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RECENT RESEARCHES UPON THE SUCCESSION OF THE TEETH IN MAMMALS.

BY HENRY FAIRFIELD OSBORN.

While American paleontologists have been making rapid advances in the phylogenetic history of mammalian teeth, the English have made notable additions to our comparative anatomical knowledge, and the Germans to the embryogenesis. The recent studies of Kükenthal, Röse and Taeker in the discovery of the complete double or milk dentition in the Marsupials, and in the discussion of its relation to that of the reptiles, also in the ontogenesis of the crowns of the teeth among the Cetaceans, Edentates, Primates and Ungulates are of the greatest interest and importance. They involve a complete revolution in our ideas as to the interpretation of the dentition in the three orders first mentioned above.

The latter authors are perhaps inclined to lay too great stress upon the testimony of ontogenesis in the order of appearance and consequent homologies of the mammalian cusps, and Röse's work is to a certain extent rendered less useful by the fact that he has substituted the conclusions of ontogeny for those based upon the more certain foundations of phylogeny. It is a subject of congratulation, however, that these authors, who constitute the rising school in Germany, recognize the value of the paleontological work done in this

country, and are ready to join hands in pushing forward these investigations upon a joint basis.

Kükenthal's Researches.

Kükenthal's studies upon toothed whales were partly directed upon the theory of Weber, Julin and others that these animals were formerly heterodont. In the embryo of the Porpoise (*Phocœna communis,*) he found traces of a heterodont condition quite sharply marked. There were twenty-five teeth in each half of the jaw, and the posterior seven were found to have two or three cusps. Having thus supported the opinion that the homodont toothed whales were primitively heterodont, Kükenthal has also proved that they are diphyodont, and that the dentition of the toothed whales is a true milk dentition, while the second or permanent dentition is represented by rudiments which display a distinct crown of enamel and even the enamel pulp, yet does not reach the surface.

In the whalebone whales in which germs of teeth had been found in the first third of foetal life, Kükenthal does not confirm the opinion of Weber that the dentition is heterodont. He denies that the posterior teeth are more complex than the nine anterior teeth, and holds that throughout they are simply conical, excepting in cases where two external teeth are fused together. This fusion of teeth does not follow any definite rule; in some cases it occurs in the anterior nine teeth. The course of embryonic development shows that these fused teeth represent an original condition, and in the opinion of the author, are to be regarded as molars. This conclusion was reached by the comparison of younger and older embryos, the number of fused teeth constantly diminishing in the latter.

Kükenthal advances the hypothesis that this was the method by which numerous homodont teeth arose from a small number of heterodont, namely, by the splitting apart of cusps. This hypothesis he promises to support by paleontological evidence. He also shows that these embryonic teeth in the whalebone whales also represent the first or milk dentition; and that the rudiments of a second series of teeth develop

beneath them. Kükenthal refers these transformations in the dentition to natural selection, terminating with diminished calcification connected with the advantage of diminished specific gravity.

His general conclusions are, that all the earliest mammals were diphyodont. This is based upon his discovery of successional teeth in Marsupials, Edentates, Odontocetes and Mystacocetes. The monophyodont and homodont condition of many mammals, such as the toothed whales, he believes has been secondarily acquired. Within the higher members of the mammalian class the second dentition is developed progressively, both as regards form and function; while in the lower divisions, the first or milk dentition is predominant. "In the rudimentary stage both dentitions are of equal value. Embryology gives us no support for the often expressed assertion, that one of the two dental rudiments has arisen in dependence upon the other. They are both sisters, whose mother is the simple invagination in the jaw, which we term the dental fold, (*Zahnleiste.*)" He continues, that there are no absolute differences between mammalian and reptilian teeth; that not one of the characters of the mammalian teeth is perfectly constant, and that the derivation of the dentition of mammals from that of the reptiles does not appear to be too hazardous. Of the several series of teeth which are found in reptiles, only two persist in the mammals.

From this I would dissent in part. The three differences between the mammalian and the reptilian teeth are shown in the capacity for the multiplication of cusps upon the crown, in the division of the fang whenever the crown becomes multicuspid, in the acquisition of the cingulum. The frequent succession of teeth in the reptiles, may be the cause of the non-progression of reptilian as compared with mammalian teeth. In the reptilia among the Theromorpha, we find true triconodont crowns, as for example in *Galesaurus*, and a heterodont dentition which closely imitates that of the mammals; but the class differences appear in the fact that in the mammalia a development of lateral cusps upon the protocone, and the stages from the protodont toward the

triconodont type, are marked step by step by the division of the fang. This law was advanced hypothetically by Cope and Wortman, and I regard it as absolutely proven by the evidence I have adduced in the study of *Dromotherium*, *Microconodon* and *Amphilestes.*

The hypothesis of Kükenthal and Röse that the numerous single pointed or homodont teeth of the whales, have arisen by the splitting up of the three cusps of a triconodont crown is an ingenious one, upon which paleontology at present throws no favorable light. *Amphilestes* of the middle Triassic with its seven triconodont molars, might by such a splitting process, furnish twenty-one homodont teeth; nevertheless this seems to me highly improbable; while the converse hypothesis suggested by Kükenthal and developed by Röse, that multicuspid crowns have originated by the fusion of single cusps, is capable of direct disproof by paleontological evidence.

The multiplication of teeth accompanying the elongation of the jaw in Cetacea, can be much more simply explained by the supposition that the dental fold was carried backward, and gave rise to new teeth caps at definite intervals. I may add that the rapid reduction of the molars in the Mesozoic period from behind forward, which reduced their number in the *Triconodontidæ* from seven to four, between the middle and upper Jurassic periods, is against the supposition that the *Amphilestes* molar, for example, furnished the material for the multiple Cetacean series.

Kükenthal's researches upon the dentition of the opossum, published in 1891,[1] mark another great step in advance in our knowledge of the dentition of the mammals. We may refer to the later researches of Röse for details, and simply quote one passage from Kükenthal:

"The permanent dentition of the Marsupials, belongs to the first series or milk dentition. Rudiments of the second dentition are actually present in an embryonic condition, but with the exception of the third premolar, they do not cut the gum." Again, the two first so-called true molars, of the

[1]Anatomischer Anzeiger, Nos. 23, 24.

upper jaw, and the first three similar teeth of the lower jaw, also belong to the first dentition and have rudimentary successors. Therefore, excepting the last upper and lower molars which appear at a late stage of development, neither dentition of *Didelphys* belongs to the so-called permanent series. This opinion has been somewhat emended by Röse.

Röse's Researches.

MARSUPIALS. Dr. Röse gives the following summary of his principal results. "When we combine the results of the foregoing researches, we find that the development of the teeth in the Marsupials follows exactly the same principle as that of man and the other mammalia. The first matrix is indicated by the dental fold, i. e. a part of the epithelium of the jaw which grows into the mesoderm aided by an extensive fold. Upon this dental fold are formed the dental caps which belong to the first series; in the case of *Didelphys*, the incisors, the canine, two premolars and the first molar. These dental caps are then immediately constricted off from the dental fold, and this ridge grows both inwards below the dental caps, and backwards behind the molar above mentioned. The posterior molars arise in exactly the same manner as I have described; in the case of man, through lateral extension of the dental ridge.

" While, however, in the case of man, the permanent ridge extends beneath the ten anterior teeth constituting the milk series and gives origin to ten permanent teeth, which cause their predecessors to be absorbed, in the Marsupials only the last premolar of the adult arises from the dental ridge of the permanent teeth. It is nevertheless, more than probable that the outer (5th) incisors of *Perameles,* as well as of Macropus and Phalangista, are built up from the permanent ridge, i. e. they belong to the second dental series. The last upper premolar belonging to the second series in some cases simply pushes its way into a gap in the first series without causing the usual absorption of the first tooth in this row. This type we find to be shown in *Didelphys,* in *Perameles,* in *Phalangista cookii,* as

well as in *Macropus.* In other cases the last premolar of the first series is absorbed, and in its place enters the premolar of the second series; this more primitive type is found in an undetermined species of the genus Phalangista; also in *Macropus lugens* and *M. gigantius*; also, according to the figures of Oldfield Thomas, in *Phascogale,* and in the fossil *Triacanthodon serrula.*

"Further researches are necessary to determine which type is the most common among the Marsupials. It also remains to ascertain through sections and models, whether the last incisor (fifth or lateral, i^5) of the upper jaw really arises from the second series, and in what species this occurs. Possibly in some Marsupials other teeth also rise from the second series. Whether this, however, is the case or not, the principal theory of Marsupial dentition is not thereby affected. It is certainly well established by my researches, as well as by those of Kükenthal, that the teeth of the Marsupials, with the exception of the last premolar and probably of the last superior incisor of some species, belong to the first series, and are analogous with the milk teeth of man and other mammalia.

"This shows that in the entire vertebrate series the principle holds good, that by the better development of the single tooth, the frequent succession of teeth of the Selachian type, is gradually limited. The Marsupials, however, in the reduction of the multiple succession of the reptilian-like ancestors of existing mammals, have together gone past the limit, and have wandered into a *cul de sac* of evolution out of which there was no return. Upon this rests the remarkable constancy of this order, from the Mesozoic period to the present time. The reduction of the former multiple succession of teeth of the vetrebates to a single series of teeth, appears therefore, only to be of service when the teeth at the same time attain a permanent growth. This stage was only attained among the Marsupials by *Phascolomys.*"

In the same paper the author restates his theory of the origin of premolars and molars by the fusion of several single teeth, and is led far astray from the actual conditions which we observe in such development. Originally, he says, the pre-

molars, like the molars, embraced three single cusps, which were arranged in the triconodont type; in Triacanthodon the premolars are altogether formed like the molars. (This observation is an error. The only Mesozoic mammal in which the premolars are even approximately similar to the molars, is *Phascolotherium.*) After the original three cusps of the premolars had been arranged in the triconodont order, he supposes, arose the degeneration of the forward cusp, leaving a tooth type which we observe especially among the Carnivora. (The cusps left here are simply the protocone and talon.)

In an earlier paper upon human dentition, the author is also led astray by ontogeny to false conclusions as to phylogeny, and at the conclusion of his extremely interesting paper upon the embryogenesis of the human dentition, he says: "The typical form of upper molars in man is unquestionably the four cusped type; while the typical form in the lower molars is the five cusped type."

EDENTATES. Dr. Röse has also contributed interesting observations upon the rudimentary development of teeth among the Edentata. He quotes Max Weber to the effect, that the reduction of the teeth in *Manis* is so absolute, that not a single rudiment remains, and that there is, so to speak, no place left for the layer either of dentine or enamel. He then goes on to say: "After, in my earlier studies, I recognized the morphological importance of the dental fold, and finding it ended as a last rudiment of an earlier dentition both in the birds and turtles, I did not doubt that also in *Manis,* at least the first stages of a dental ridge must be present in the early embryonic development." With material received from Professor Max Weber himself, Dr. Röse demonstrates the beginnings of the dental fold both in the upper and lower jaws of Manis; and in the lower jaw on both sides he finds even an unmistakable rudiment of the tooth layer, in the form of a swollen portion of the common dental fold, i. e. an abortive tooth cap. Such results were obtained in *Manis javanica.*

The forms investigated were the Nine-banded Armadillo (*Dasypus novemcinctus*), *Dasypus hybridus,* the Pangolin (*Manis javanica*), and the Anteater (*Myrmecophaga.*) In the Nine-

banded Armadillo most careful researches were made upon the dental ridge in a series of 420 sections, leading to a discovery which was confirmed in the other species, that the dentition of the Edentata has arisen by degeneration from the dentition of a more highly organized mammalian type. This result is directly contradictory to the hypothesis of Oldfield Thomas, that the Edentata were sharply marked off as *Paratheria* by the exceptionally simple features of their dentition among other characters.

Dr. Röse continues, that the enamel of the teeth has so far retrogressed, that only an upper capping of the enamel layer is formed, which lies directly upon the dentine. "In all cases in which we have instituted exact microscopical researches, in three species of Dasypus, and in Orycteropus, it is proved that invariably in the Edentata the typical two dentitions of the mammalia are exhibited in the embryonic stages. In every case as the tooth is constricted off, the dental ridge grows further backwards, as the basis of the successional tooth, as it has been observed in the development of the teeth in man and in the Opossum; and as Kükenthal observes, from a morphological standpoint it is of no moment whether this replacing ridge gives rise to teeth or not."

Dr. Röse anticipates that the Bradypodidæ will also prove to be diphyodont.

This author further shows that there are proofs of heterodonty which weigh against the opinions of Parker and Thomas, that the Edentata stand entirely aside from the other mammalia.

In the early stages of development, a continuous dental ridge is found in the whole jaw, and in the anterior part of the jaw two rudimentary teeth are observed which must be regarded as incisors. According to Rheinhardt, the number of rudimentary incisors in the Nine-banded Armadillo is still greater (four). The lateral tooth in Bradypus may be either an incisor or canine. Dr. Röse agrees with Tomes and Osborn that the canine should be considered as the most anterior premolar. Another question arises as to whether the posterior teeth of the Edentata are to be regarded as molars or as divided into molars and premolars. As Kükenthal has

observed in the whalebone whale, we also find in young embryos of the Edentates a double pointed or biconodont tooth, which later divides secondarily into its single pointed components. The author considers it doubtful whether this biconodont type is primitive, or as seems to him more probable, is derived by degeneration from a triconodont type!

As regards the bearing of paleontology and comparative anatomy upon these facts, we find rudimentary incisors in the living *Dasypus setosus* and in the fossil *Chlamydotherium.* The latter shows the fusion of two conical points. The author refers also to Glyptodon, which has prismatic back teeth with a very evident triconodont type. He concludes by saying that these circumstances afford a very marked support for the opinion, that the present biconodont teeth of these Edentata, at least the posterior members of the series, have arisen by reduction of a typical triconodont type. If this is confirmed by further observation, it will be a fact of the very greatest importance in the phylogeny of the mammalia. For the triconodont type has been shown to prevail in the upper Triassic and lower Jurassic periods. There was unquestionably a vast period in the evolution of mammalia in which a triconodont molar was the only type.

SAUROPSIDA. In the conclusion of his work upon the development of the teeth in the crocodile, he reaches the following result: "The cause of the existence of the thecodont (fangless) teeth is to be found in the continuous growth of the epithelial sheath of Hertwig. . . . . The functional tooth of the crocodile is altogether analogous with a rooted mammalian tooth, the growth of which is not yet complete. The first embryonic tooth series of the crocodile, on the other hand, exhibits a development which we hitherto have only observed in the Selachia and Urodela through the labors of Hertwig. The theory of Hertwig as to the genesis of the mouth skeleton out of the cement sockets of tooth structure, has received an unexpected and weighty support by our researches."

The types examined by the author, included *Sterna Wilsonii,* the Ostrich, *Struthio camelus* and the turtle, *Chelone*

midas. He anticipated from his studies upon the tooth development of the reptiles, that only traces of the dental fold would be found, and if any really rudimentary dentine teeth were found, they could only represent those primitive Selachian-like teeth which constitute the first series of the crocodile. In the crocodile as above noted, a first dental layer exhibits itself altogether similar to the placoid scales and the first teeth of the Selachians in the form of free papillæ upon the surface epithelium of the jaw.

Taeker's Researches.

Dr. Taeker of the Veterinary Institute of Dorpat, has completed a most interesting series of studies upon the embryonic form of the teeth in the Ungulates.

His technical methods were an improvement on those introduced by Klever, and his material included embryos of the horse as a type of the most complex form of perrissodactyl, of the pig as a modern bunodont, and of Selenodonts he selected the embryos of the Elk, Deer, Ox and Sheep, and of greater rarity, an embryo of one of the group of Tragulids. His conclusions are summed up as follows:

1. As a result of my investigations I find that both the Suidæ with rounded or bunodont cusps, and the Ruminants with their crescentic or selenodont cusps, arise from a similar initial bunodont stage; that is, all the highly complex forms of modern cusps spring from the simple ancestral hillock in the embryonic stages.

2. The order of differentiation soon follows, in which the separate cones and conids (cusps of the lower jaw) are transformed into pyramids in the case of the pig, and into crescents in the case of the ruminants.

3. The transformation of the cones is not effected simultaneously, but successively. In the upper teeth it does not begin with the protocone (antero-internal cusp which is first developed in the paleontological history), but with the external cusps, the paracone and metacone.

Order of Appearance of the Cusps. The author observes that while in the lower jaw the order and appearance of the cusps is the same in the embryo as in the paleontological history, in the upper jaw this ontogenesis is no longer parallel with phylogenesis, (as regards the upper teeth, this exception is confirmed by Röse). In fact the external cusps not only appear before the internal cusp, which paleontology shows to be more primitive but they assume the crescentic form earlier. In other words, their development is accelerated.

The development of the premolars is also traced and it is interesting to recall the fact that in the paleontological history, the order of evolution of the cusps of the premolars is not the same as that of the molars. Taeker's results therefore show a parallelism between Ontogenesis and Phylogenesis, in that he proves that the embryonic cusp order in the premolars is different from that in the molars, and is approximately similar to that in the ancestral history as recently worked out by Scott.

Upon the whole this parallelism between embryogenesis and palingenesis is most striking, and I think we can explain the exceptions which Taeker and Röse have shown to occur in the upper teeth both in the Primates and Ungulates, in the following manner: In the most primitive types of trituberculates, the protocone was the most prominent cusp in both jaws. This is seen in all the known Triassic and Jurassic trituberculates without exception. During the Cretaceous period a change took place, in which the upper molars rapidly diverged in pattern from the lower molars. The lower were more conservative, retaining the trigonid or triangle in its primitive proportions. The upper molars, on the other hand, must have undergone a marked change, consisting mainly in the depression of the protocone below or to the level of the paracone and metacone, as seen in the primitive Carnivores, Creodonts, and Insectivores of the Puerco period. Thus we find both in the Ungulates and sub-Ungulates or early Primates, that in the upper molars the outer two cusps are slightly more elevated and decidedly more progressive in the acquisition of new forms than the older internal protocone. For example

the outer cusps often became crescentic, while the inner cusp remained rounded. And it was therefore during all the lower Eocene, that the external cusps surpassed the internal cusps in progressive development.

The bearing of these facts is this: in Embryogenesis, we are dealing with repetition of ancestral history; we should not expect, however, that this repetition would invariably extend back of the form characteristic of the Eocene period. As a matter of fact, the upper molars repeat their Eocene but not their Mesozoic form. The lower molars also repeat the Eocene form, and this, as explained above, owing to the conservative proportions of the cusps, is also the Mesozoic form, the protocone still being the most prominent cusp in the crown. While, perhaps, not thoroughly satisfactory, there is a great deal of probability that the discrepancy between the embryonic and phyletic order in the upper molars, is due to these differences in their phyletic history.

In the accompanying table I have summed up the phylogenetic order observed by Cope and myself, and the ontogenetic order observed by Röse and Taeker.

The Fusion Theory of Cusp Origin.

As we have seen, the fusion theory was first proposed by Kükenthal; it was afterward independently advanced by Röse. We find in addition to the grounds given above, one very strong argument against this theory derived from Paleontology, is in the law of molar evolution, namely, that the cusps appear at or near the apex of the crown, and development takes place from above downward. Thus, so far as we can judge from *Dromotherium* and *Microconodon*, the lateral cusps first appear on the sides of the protocone, and much later, the fang subdivides; the lateral cusps are at the outset very much smaller than the medium cusp, and it is only after a long course of evolution that they attain the same size.

Now, if the fusion theory were correct, and the triconodont crown, for example, were constituted by the fusion of three

Table showing the Phylogenetic Order as observed by Cope and Osborn, and the Ontogenetic Order as observed by Röse and Taeker.

A. Phylogenetic Order. **B. Ontogenetic Order.**

Geological Periods	Order.	Cusps Comparative—Human.)		Primates[2])	Marsupials[2])	Ungulates[3])	Order.
		Upper molars.					
Permian	1	Protocone	Ant. lingual.	Paracone	Paracone	Paracone	1
Triassic & Jurassic	2 & 3	Paracone	" lateral.	Protocone	Proto- "	Meta- "	2
		Metacone	Post "	Metacone	Meta- "	Proto- "	3
Cretaceous	—						
Eocene & Miocene	4	Hypocone	Post. lingual.	Hypocone	Hypo- "	Hypo- "	4
		Lower molars.					
Permian	1	Protoconid	Ant. lateral.	Protoconid	Protoconid	Protoconid	1
Triassic & Jurassic	2 & 3	Paraconid	(degenerated[1])	Metaconid	Para- "	Meta- "	2
		Metaconid	Ant. lingual	Hypoconid	Hypo- "	Hypo- "	3
Jurassic	4	Hypoconid	Post. lateral	Entoconid	Ento- "	Ento- "	4
Cretaceous	5	Entoconid	" lingual	Hypoconulid	Meta- "		5
Lower Eocene	6	Hypoconulid	" mesial				

[1]) This cusp degenerates both in the early Primates and Ungulates.
[2]) As I understand Dr. Röse.
[3]) As I understand Dr. Taeker.

distinct cones, these cones should certainly appear sub-equal from the first, and they should present a division extending to the base and indicated in the fang. From the fact that Kükenthal does not mention the above genera, we infer that his attention has not been called to them. In one of his latest addresses he speaks as if the multituberculates were the only Triassic mammals. We know that the trituberculates were as old or older than the multituberculates, and reasoning by analogy, I have attempted to show elsewhere that the multituberculates will be found to have a trituberculate origin.

As I have lately criticised this theory in some detail in the "Anatomischer Anzeiger," I here refer to the well-known evidence which renders the Kükenthal-Röse hypothesis both superfluous and untenable; when we find in the series such as is represented by the genera Dromotherium, Microconodon, Spalacotherium, Amphitherium, Miacis, exhibiting in the lower jaw all the stages between the sectorial and bunodont crown, and when in the early Ungulates we are able to trace one by one the successive additions of cusps to the bunodont molar, often in the center of the crown, it certainly is not necessary to attempt to establish any new hypothesis as to cusp origin.

Summary of Results.

The general bearing of these researches upon the stem forms of the pro-mammalia is extremely important. To summarize, it is rendered probable that the earliest forms of mammals were homodont and had two or more series of successional teeth. Then within the mammalian stem the teeth were differentiated, and there arose a great heterodont group with teeth at least of three kinds—incisors, premolars and molars, all successional. From the most anterior premolar arose the canine. Then came the division between the Marsupials and the Placentals, the former tending to suppress the develop ment of the second series of teeth, the latter retaining the second series as far back as the first molar.

We can see an obvious advantage in the line of succession

being drawn at the first molar,[1] for upon the molars rested the necessity of complex development, and such development was best effected in permanent crowns.

1. All the so-called "milk molars" plus the so-called "true molars" constitute the *first series*. Beneath one or more of the "true molars" in lower mammals are rudiments of a second series. The *second series* consists therefore of these sub-molar rudiments plus the successional or permanent premolars, incisors and canines.

2. In the stem Marsupials the entire first series persisted and became mainly permanent (non-deciduous); the second series became rudimentary and non-successional with the exception of the fourth upper and lower premolars and possibly one or two other teeth which either replaced or were intercalated between members of the first series. One or more premolars were suppressed and one more molar retained than typical in the Placentals. Thus is explained the apparently atypical dental formula of Marsupials.

3. In the stem heterodont Placentals (excepting the Cetacea and Edentata) the entire first series persisted and all the incisors, canines and premolars remained deciduous. The successional second series persisted as far back as the first molar.

4. In the stem Cetacea the entire first series persisted and the second series became rudimentary and non-successional. The tooth form changed from a heterodont to a homodont type.

5. In the stem Edentates, which also transformed from the heterodont to the homodont type, the first series became rudimentary and the second series persisted in the succession even behind the region of the first molar.

Finally, there is evidence that a primitive succession in the region of the molar teeth, lost

[1]The law of molar evolution is that complication is most rapid in teeth which are longest in use. Thus the first molar is the most progressive tooth of the true molar series and the last premolar is the most progressive of the premolar series. The apparent exception that the third milk premolar is always an advance type of the third permanent premolar is explained by the fact that the milk premolars are formed to assume the molar function.

in the Marsupials and in the Placentals, was more or less fully retained in the Cetacea and Edentates.

Biological Department, Columbia College, April 10, 1893.

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PLATE XIII.

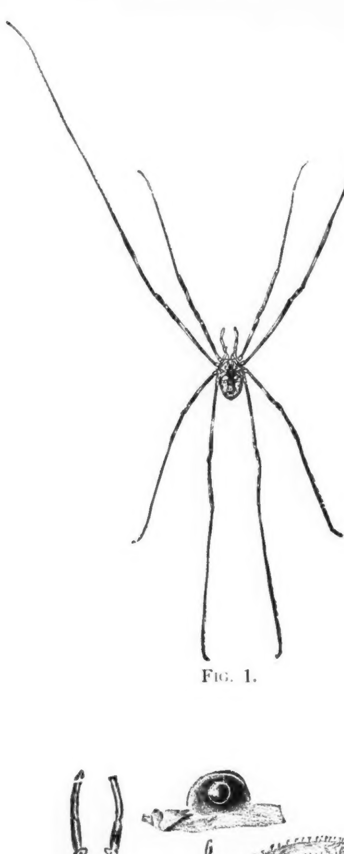


FIG. 1.

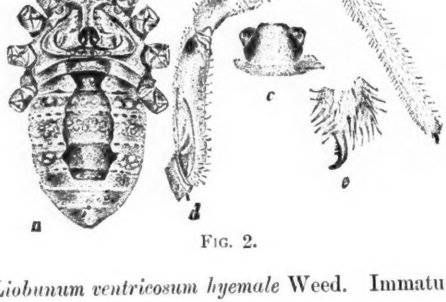


FIG. 2.

Liobunum ventricosum hyemale Weed. Immature.

SYMBIOSIS AND MUTUALISM.[1]

By Roscoe Pound.

Symbiosis and mutualism, in the vegetable kingdom at least, are phenomena accompanying parasitism. Parasites have various effects upon their hosts, according to the nature of the parasite, its mode of life and method of attack. In some cases the host is quickly killed and the parasite becomes a sort of saprophyte upon the remains. In others the host lives longer or is only partially affected. In still others the host lives on side by side with the parasite indefinitely. A further development is attained in cases where the parasite and host not only live together, but are mutually beneficial, and, perhaps, even, in extreme cases, inter-dependent. To the first phenomenon —namely, the living together of parasite and host—DeBary, in 1869, in a work entitled *Die Erscheinung der Symbiose,* gave the name of Symbiosis. The latter phenomenon—i. e., mutual assistance or inter-dependence of parasite and host—was named mutualism in 1873 by Van Beneden in his "Animal Parasites and Messmates." Symbiosis in the strict sense and mutualism are often confounded, that is, the term symbiosis is often used to mean mutualism as such; but, in strictness, while mutualism, in the case of plants, can only exist with symbiosis, in the larger proportion of cases of symbiosis there is no mutualism.

At the outset it should be noted that the mutualism of which we are here speaking is mutualism of parasite and host—not mutualism of independent organisms. Of the latter, we have many examples in the animal kingdom, and, indeed, the human race furnishes examples of it. There is a sort of mutualism between man and wheat, for example. Wheat is cultivated by man and enabled to grow in quantities, and in localities which, under ordinary conditions, would be impossible. It gains this partial exemption from the struggle for existence only at the expense of an immense number of indi-

[1]Read before the Botanical Seminar of the University of Nebraska, December 17, 1892.

viduals sacrificed, but it is, nevertheless, a great advantage which it gains. This may be called mutualism. But there is a case of mutualism of plant and animal much more closely resembling the mutualism of parasite and host in the vegetable world. The mutual inter-dependence of *Yucca* and a moth of the genus *Pronuba*, is probably the most unique and interesting case of mutualism to be found anywhere. This is well described by Mr. Webber in the AMERICAN NATURALIST for September, 1892. In this case the plant and the moth, if not strictly sustaining the relation of parasite and host, live together for a long period, and it approaches much closer to mutualism as found between vegetable organisms than phenomena like entomophily where animals and plants are mutually beneficial, without any approach to symbiosis. In the vegetable kingdom, mutualism is a relation of mutual benefit between organisms living together as parasite and host.[2]

The most conspicuous and earliest observed instance of mutualism in the vegetable kingdom is the relation of the Lichen fungi to their gonidia or algal hosts. The relation of the lichen thallus to its contained gonidia was, at one time, the subject of no little ridicule, not only because its discovery overturned many established ideas, but because it really did seem at variance with common sense. A parasite of far larger size than its host, controlling the growth of its host—not growing within or upon the host, and following its growth at a distance, but growing outside of the host, spreading in all directions of its own motion, and being followed by the slower growth of the host—such a parasite was indeed a novel phenomenon. We cannot blame the lichenologists of the old school for their facetious remarks about the horse parasitic upon the bot and the symbiotic relations of Jonah and the whale.

If all lichens were the large, robust parasites that the commoner lichens are, we should have reason to hesitate long before accepting so remarkable a phenomenon as established.

[2]The case of the bacteria in the "pitchers" of *Nepenthes* and other carnivorous plants seems, according to the investigations of Tischutkin, to been exception. See AMERICAN NATURALIST, May 1893.

Fortunately, the lichens exhibit several intermediate forms, and enable us to see the relation between the phenomenon found in the commoner lichens and ordinary parasitism.

Lichenologists have, for a long time, distinguished, under one name or another, two classes of lichens. In the one group the thallus is entirely or substantially homogeneous—there is no differentiation into rind, medulla, etc. In the other there there is a well-defined rind, and gonidial and other zones are differentiated. The former have been called homœomerous lichens, the latter heteromerous lichens. In the first group the alga is the principal part of the lichen. The hyphæ grow within the mass of algal cells and follow them in their growth. To this class belong *Collema* and like genera, which are fungi parasitic upon *Nostoc, Scytonema*, etc., and growing within the gelatinous membranes and sheaths enveloping those algæ. Here there is symbiosis—a living together of parasite and host —but no one will contend that there is mutualism.

In the second group the fungus is the principal part of the lichen. It contains in its thallus a zone of algæ, but they follow the growth of the thallus, and their bulk is a small proportion of the whole lichen. In these lichens the algæ are *Protococcoideæ* or *Palmellaceæ*, etc., and to the different mode of growth of these algæ the difference is largely to be attributed.

Between these groups there are a number of forms, usually classed as heteromerous lichens, which, nevertheless, show no differentiation of medulla and rind, and in which the thallus consists of a weft of slender hyphæ growing around filaments of *Chroolepus* and like forms. Still another fact is important in this connection. Some of the genera of this intermediate group have species which contain no gonidia and are saprophytes upon bark, and indeed the parasitic species are often saprophytes during a part of their existence. Many genera of fungi exhibit the same phenomenon.

It is seen, then, that mutualism does not exist in all lichens, and that the steps from an ordinary case of parasitism, such as that exhibited by the homœomerous lichens, which consist of a mass of algal cells permeated by the hyphæ of a fungus and often distorted by it, to the peculiar case of the heteromerous

lichens, where the fungus forms an extensive thallus in a zone of which are contained the algæ upon which it subsists, may be traced in existing species. Not only this, but there are genera, as has been said, in which there are species that do not attack algæ, but live independently as saprophytes, and the point to be noticed here is that these genera belong to the intermediate group of what I may call pseudo-heteromerous lichens.

These considerations, of course, do not prove the existence of mutualism in lichens, but they deprive it of much of its seeming unreasonableness. Other facts, now well established, make it certain that this relation really does exist in the heteromerous lichens.

Arthonia is one of the pseudo-heteromerous lichens. Moreover, it is one of those genera in which certain species, during their entire existence, live independently as saprophytes. Of its development, De Bary says: " . . . . the hyphæ of the thallus make their way into the outer layers of the periderm in the smooth stems of oaks and ashes and there grow as saprophytes independently, that is, without algæ, into a thallus formed of an abundance of slender hyphæ which spread through the cells of the periderm. Then its proper alga, *Chroolepus umbrinum*, finds its way from without through the cell walls of the peridermis into the previously formed hyphal thallus and is seized by it. The cells of the *Chroolepus* are in rows forming filaments with apical growth, and it is by means of this growth that they penetrate into the thallus in the same way as mycelial hyphæ pierce through membranes. The alga is a frequent inhabitant of the bark of trees, and makes its way into the periderm for its own purposes. Its penetration into the thallus of the fungus can scarcely be supposed to be caused by the fungus, but is merely an adaptation which favors the formation of a lichen." This is plainly an ordinary case of parasitism on the part of the lichen, but it not only throws light on the origin of the true heteromerous lichens, but it shows in what manner the fungus may be of benefit to the algæ. In the heteromerous lichen the thallus takes the place of the bark of the tree in these pseudo-heteromerous lichens.

The gonidia of the heteromerous lichens are usually *Palmellaceæ,* which, from their different structure and mode of growth, have not the power of getting beneath the bark as does *Chroolepus.* The thallus of the lichen serves the same purpose with them—protecting the colony of algæ and absorbing and retaining unusual quantities of moisture, and enabling them to live and multiply in places where, under ordinary conditions, life would be impossible.

That the thallus does do this is shown by the fact that lichens grow in places where algæ could not maintain themselves unaided, and by the fact that the gonidia multiply with great rapidity in the thallus, often more so we are told than without, and the individual cells attain a larger growth within the thallus than without, as has been shown by taking algae from the thallus and cultivating them independently. That the fungus does not do all this for nothing, the numerous exhausted cells to be found in the gonidial zone of any ordinary lichen abundantly testify.

There is another curious phenomenon exhibited in some lichens. In these species the algæ are not confined to the gonidial zone, but grow up into the tissues of the sporocarps between the paraphyses and among the asci, so that when the ascospores are ejected, cells of the algæ are ejected with them and are promptly seized upon by the germinating spores. This can hardly be accidental, and it should be observed that it is the alga which is the moving party, not the fungus. Surely some benefit must result to the alga or it would not be done.

It is possible, also, that there are other adaptations resulting from the symbiosis of fungus and alga in the lichen. Frank claims to have discovered several, one of which deserves mention. It is well known that algæ can be separated from the lichen, and that they will then vegetate in the ordinary way independently. Frank asserts that certain species of algæ have become so adapted to life in the lichen and so accustomed to it, that they have partially or wholly lost the power of independent growth. No examples of this, however, are certainly known.

Frank also claims that the fungus exhausts the protoplasm of algal cells without entirely destroying them. If by this is meant that it does not always entirely destroy the cells it attacks, it is probably so, but if anything more is meant, it seems, like some other theories of Frank, which I shall have occasion to mention presently, if I may say so, decidedly "fishy." Such a thing is not necessary to mutualism. The alga can purchase the protection of the thallus only by the sacrifice of a large number of individual cells. If it gets *quid pro quo*, why should it not prefer to sacrifice them to the fungus in return for the shelter of the thallus rather than to leave them victims to natural conditions without compensating advantage. To put the matter in another way, if the energy spent by the alga in producing cells to be destroyed by the fungus were put to making a shelter of its own, could it effect as much as it does by taking advantage of the thallus?

Two other cases in the vegetable kingdom where mutualism is thought to exist remain to be examined. These are the cases of "*Pilzsymbiosis*" or "*Wurzelsymbiosis*" of the roots of anthophytes and certain fungi. The first noticed was what is termed "*Mycorhiza*," and of this first.

T. Hartig, in 1840, and others since, had noticed mycelia apparently parasitic on the roots of trees. In 1885, Frank published the results of investigations of mycelia growing upon the roots of various *Cupuliferæ* in which he claimed that the sustenance of these trees depends upon fungi symbiotic with their roots. The title of his paper indicates his claim: "*Ueber die auf Wurzelsymbiose beruhende Ernaehrung gewisser Baeume durch unterirdische Pilze.*" To begin with, Frank found that certain *Cupuliferæ* have almost the whole of their root system covered with mycelium associated symbiotically with the root, and he claimed that these fungi took the place of root hairs, and were the only means of absorbing water, etc., possessed by the roots, though, of course, like the gonidia of lichens, the roots could be grown independently in water cultures for years.

The mycelia, of the existence of which there is no doubt, are probably connected with some of the *Gasteromycetes* or *Tuberaceæ*. But Frank observes that the presence of a mycel-

ium does not necessarily imply the presence of the perfect fungus fructification, as mycelia may, and often do, go on growing in a sterile condition for years.

Frank did not stop here. He found symbiotic fungi on the roots of many other trees, and others after him found mycelia on the roots of various plants to which he attributes the same relations of mutualism. His final statement is that this phenomenon belongs " to all trees under certain conditions ; " that " the Mycorhiza is formed only in a soil which contains humous constituents or undecomposed vegetable remains ; " that " the development of Mycorhiza increases or diminishes with the poverty or richness in these constituents ; " and that " the fungus of the Mycorhiza conveys to the tree, not only the necessary water and the mineral nutritive substances of the soil, but also organic matters taken direct from the humous and decomposing vegetable remains." Finally, he claims that only through the fungus can the tree employ such organic matter directly.

If the fungus develops only in soil containing undecomposed vegetable remains, we might ask why it takes the trouble to attach itself symbiotically to the root and give the tree the benefit of its saprophytism ; especially, as Frank says that the protoplasm of the cells and the fungus live together " without the former being parasitically affected or its vital phenomena disturbed." This reminds one of the exhausted gonidial cells which are still uninjured, and is not the only one of Frank's statements calculated to try our patience and credulity.

In 1886, Warlich (*Botanische Zeitung,* 1886, p. 481, et seq.) investigated certain fungi on the roots of orchids. He examined several hundred species, all of which he found affected on both aerial and subterranean roots with the mycelia of what he showed to be a species of *Nectria.* The hyphæ of this fungus affect spots here and there, forming knots or coils in certain cells and causing them to enlarge, but, as a rule, only partly filling the cell and not destroying the protoplasm. Frank, of course, took this up, and he claims that the protoplasm of the cell is not affected or disturbed by

the fungus; that the fungus is strictly connected with that part of the plant which absorbs the food materials; and that those orchids which are chlorophyll-less, and therefore depend on the humus of the soil for carbonaceous matter, always exhibit this fungus highly developed. Accordingly, he includes this too in Mycorhiza, calling it " endotropic Mycorhiza " (i. e. the hyphæ live *in* the cells) as opposed to " ectotropic Mycorhiza " in which the fungus is entirely *outside* of the cells.

As to Frank's statement that the protoplasm of the cell is not affected by endotropic Mycorhiza, Marshall Ward, in the *Annals of Botany* for February, 1888, says: " This can only be an assumption, and the impression I gather from the study of what is known of this orchid fungus is in favor of the view that the fungus *does* disturb or 'parasitically affect' the protoplasm of the cell, and that an outward and visible sign of some such action exists in the hypertrophy of the cells affected and in the turning yellow of the chlorophyll-grains."

R. Hartig, a more sober and trustworthy writer than Frank, said the last word so far on Mycorhiza in 1891. He admits that the mycelia of some of the *Tuberaceæ* or *Gasteromycetes* are found symbiotic with the roots of certain trees. But his conclusion is that they are of no use to the tree, and are probably injurious by taking nourishment properly belonging to the tree. It would seem that they must do this, even were there mutualism between them and the roots—else why are they there? Organisms are not given to gratuitously assisting one another. Mycorhiza undoubtedly exists—i. e., mycelial stages of many fungi of different groups are parasitic upon and in the roots of anthophytes. But that there is, in any of these cases, more than the ordinary symbiosis of parasite and host, has not been shown, and is improbable. That every tree has its root system covered with mycelia, proves nothing. Every tree has its bark covered with lichens, its twigs with black fungi, and its leaves with parasitic fungi of every description.

The second case of " *Wurzelsymbiosis* " is the root tubercles of the *Leguminosæ.* These tubercles have long been known upon clover, and of late years—since 1885, in fact—have been found upon nearly all of the *Leguminosæ.* Naegeli found a

Chytridium-like parasite in the cells of *Iris* which has never been seen since, and named it *Schinzia.* So when, in 1879, Frank first worked upon clover tubercle, he considered it similar to Naegeli's *Schinzia,* and named it *Schinzia leguminosarum.* Subsequently, a tubercle was found on the roots of *Alnus* by Woronin, called by him *Schinzia alni.* Tubercles have been found in this country on the roots of *Ceanothus,* and are known on a few other plants besides the *Leguminosæ.*

There has been considerable uncertainty as to the cause of clover tubercle and the nature of the parasite to which it is due. Schroeter took the parasite for a Myxomycete similar to *Plasmodiophora* and named it *Phytomyxa.* Marshall Ward, in the article cited, compares it to the yeast fungi. De Bary, in 1884, dismissed the matter with a sneer. Frank now puts the parasite among the *Schizomycetes,* and, indeed, the best view seems to be that the parasites are bacteria pure and simple. There are, in some tubercles, hyphæ, or something very like hyphæ, which Frank now calls "*Infektionsfaden.*" Marshall Ward considered these the hyphæ of which what some call the "*baktroiden*"—i. e., the bacteria—were spores. Schroeter saw in them a plasmodium. Frank, always unique and startling, has finally (1891) decided that the "*Infektionsfaden*" have nothing to do with the fungus, but are products of the host for the purpose of self infection! These hyphæ are usually filled with the "*baktroiden,*" and Thaxter's recent discovery of *Myxobacteria* may throw some light upon their true nature. In an article in the *Torrey Bulletin* for July, 1892, Mr. Schneider concludes that these tubes have nothing to do with the bacteria, or *Rhizobia,* as Frank now calls them, and considers them hyphal fungi related to the parasite of *Alnus* tubercle. As these tubes often contain the bacteria, this seems improbable. From all that I have read and seen, I am satisfied that the parasites are bacteria, and I see no reason for separating them from the rest of the *Schizomycetes* as Schneider does. I even doubt the necessity of creating a separate genus for them, as Frank did in 1890, under the name of "*Rhizobium*" (*Pilzsymbiose der Leguminosen*).

These tubercles are fine examples of symbiosis, and it has recently appeared probable that they exhibit mutualism of an unexpected kind, analogous to that claimed by Frank for his Mycorhiza. I can only go into this briefly. It is known that the plant cannot directly assimilate free nitrogen. Yet, as Marshall Ward puts it, "For a long time it has been generally known that the *Leguminosæ*, especially, have what we may term a special aptitude for seizing large quantities of nitrogenous substances from the soil, and this problem has become a classical puzzle in vegetable physiology." In 1886, Hellriegel and Wilfarth published some investigations of this matter. Subsequent experiments founded on theirs have been very numerous, and are yet in progress, but their researches remain our principal authority on the subject. Without detailing them, I may say that these researches seem to demonstrate that this power of taking up large quantities of nitrogen depends entirely upon the presence or absence of the tubercles —that without them it does not exist, and that it exists in greater or less degree according to their abundance. Conceding this, two theories are possible as to the cause.

In 1888, Marshall Ward appeared to think that the parasite stimulated the cells to extraordinary metabolic activity, and that was probably all it did. This view has had no followers so far as I can find.

The other possible theory is that the parasite does this work and the host takes advantage of it. Frank, as might be expected, takes this view. The most recent observations seem to have settled pretty thoroughly that the tubercles do assist the plant in some way in assimilating free nitrogen, and that here is a case of mutualism analogous to that of the lichens. The bacteria (as I assume that they are) are parasites. They are there for their own purposes, and are incidentally beneficial to the plant. The plant, it is generally admitted, can exist and thrive without them. In some cases it appears, and the analogy of the lichens makes this probable, that the bacteria are purely parasitic, and that there is symbiosis without mutualism. But, in most cases of the *Leguminosæ*, it seems to be shown that the plants affected do better than those unaf-

fected. Much research is needed in this matter. The manner in which the parasite acts and the host takes advantage of its work are not known with any certainty.

To these probabilities, Frank adds certain characteristic improbabilities. One has already been spoken of, namely, that the plant develops tubes or hyphæ for the purpose of self-infection which it sends through its tissues. This is somewhat like the algæ in some lichens which grow up among the asci in the sporocarp and are ejected with the spores. Only the latter is an established fact, the former a feat of the imagination. Another of his ideas, pronounced a "settled fact" by Schneider in the article cited, is that "at the close of vegetation and on other special occasions, the plant reabsorbs the protoplasm of the fungi." After all the trouble of self-infection to which the host has been, this seems rather like killing the hen that laid the golden egg. There is no sufficient evidence to establish so remarkable a phenomenon. Finally, Frank thinks that the roots of the *Leguminosæ* possess the power of attracting *Rhizobia*, due, as he considers, to some secretion. This is too much for his followers, and I think all will agree that it is the last straw of an unsupportable load with which he has already burdened our credulity. The exuberance of Frank's enthusiasm, however, should not blind us to the fact that some relation of mutualism between the *Leguminosæ* and the tubercle parasites probably—almost certainly—does exist.

It is not necessary, as Frank seems to think, in order to establish mutualism to show that the organisms do no injury to each other. Mutualism of the kind we meet with in the vegetable kingdom involves sacrifices on the part of the host. The parasite is not there gratuitously. It is there to steal from its host the living it is hereditarily and constitutionally indisposed to make for itself. If the host gains any advantage from the relation, it can only do so by sacrificing—by giving the parasite the benefit of its labor that it may subsist. If the plant or the plant colony benefits as a whole, it purchases the benefit by the sacrifice of certain parts or individuals. Mr. Webber, in a note on the Yucca moth in the AMERICAN NATURALIST for Sep-

tember, 1892, makes a significant remark to the same effect: "The larva of *Pronuba* uses up only from 10 to 12 seeds, so that even in those capsules where the most abundant larvæ develop, hundreds of good seeds are nevertheless developed. The few seeds destroyed may well be sacrificed to insure the pollination and development of the others."

Ethically, there is nothing in the phenomena of symbiosis to justify the sentimentalism they have excited in certain writers. Practically, in some instances, symbiosis seems to result in mutual advantage. In all cases it results advantageously to one of the parties, and we can never be sure that the other would not have been nearly as well off, if left to itself.

EVOLUTION AND DICHROMATISM IN THE GENUS MEGASCOPS.

BY E. M. HASBROUCK.

INTRODUCTION.

The subject of Dichromatism has ever been a stumbling-block to scientific research, and from the time of its earliest admittance into zoological discussion, has been without apparent cause and without explanation. Few, if any, theories have been published as to what it really is, or as to the possible influence governing it, while any theories that have been advanced stand without proof of their correctness; a new theory, therefore, cannot be considered as conflicting with any *settled* doctrine upon the subject. When we find a peculiarity common to all forms of animal life, it becomes apparent that if thoroughly understood in one form, a flood of light will be thrown upon the same perplexing problem affecting the rest of the animal kingdom.

In attempting to explain the causes and effects of dichromatism in the Screech Owl, no stone has been left unturned to prove the correctness of the views herein set forth. The writer has labored lovingly and patiently, following a course of reasoning which he believes to be correct, and in submitting his work and its results to fellow-workers would ask for it their kindly consideration. The collection of the necessary data has been an extremely difficult task, and more information is still desirable from certain localities, although sufficient has been received to make possible the construction of a comparatively accurate map of the color distribution. It is a lamentable fact that scientific observers of bird life are exceedingly scarce in the southern states and in the lower part of the Mississippi Valley. The data obtained from these regions, although to a certain extent more scanty than could be desired, has been used to the best possible advantage. In obtaining information, copies of the following circular letter

were sent out by the National Museum, and the matter received in reply was turned over to me for study and investigation, together with the privilege of preparing the results for publication.

UNITED STATES NATIONAL MUSEUM
UNDER DIRECTION OF
THE SMITHSONIAN INSTITUTION.

Dear Sir:

The National Museum is engaged in a systematic investigation of the color-phases of the Screech Owl (*Megascops asio*), with the view of determining the relative abundance of the red and gray plumages in different parts of the country, the plumage of the young, produced by parents of known character as to plumage, and the other related questions.

In order that the investigation may be as thorough as possible, assistance in the matter is requested; and if you can give information on the subject, your kind co-operation will be much appreciated.

Should you favor us with any information on the subject, please arrange the data in the following order:

(1) Name your locality, including County and State.

(2) State about how many specimens have come under your notice, and how many of them were in the gray plumage.

(3) If you have obtained or observed a pair of old birds with their young, state the character of plumage of the former (whether both red, both gray, or one red and one gray—and if the latter, the sex represented by each phase), and also the plumage of the young.

The above are the principal points upon which information is desired, but any additional memoranda will be very acceptable.

Yours truly,

ROBERT RIDGWAY,
Curator, Department of Birds.

In conclusion I wish to express my gratitude to Professor G. Brown Goode, Assist. Secretary of the Smithsonian, and Mr. Robert Ridgway, Curator of Birds, who rendered every assistance and courtesy in their power; while to all who responded to the request for information, without which the task would have been impossible, is due the sincere thanks of The Author

PART I.

RELATIONSHIP OF DICHROMATISM TO EVOLUTION.

So universally adopted has the theory of evolution become, that it scarcely seems necessary to refer to it as forming the

foundation of the theory here advanced, regarding the dichromatic phases of the common Screech Owl (*Megascops asio*).

"In the Systema Naturæ (Vol. I, 12 Ed., 1766, p. 132), the Red Owl is first described by Linnæus under the name of *Strix asio.* Twenty-two years later (1788) Gmelin described (Systema Naturæ, Vol. I, 13 Ed., p. 289) the Mottled Owl as *Strix nævia.* In 1812, in the fifth volume of his American Ornithology, Alexander Wilson re-describes the two under the same names, also as distinct species, and not until 1828 does it appear to have been publicly hinted that the two were really identical, when Prince C. L. Bonaparte united them, he considering the red bird as the young, and the gray the old. Audubon, in 1832, sustains this view; one of the red birds he figures as the young, being one he reared from a fledgling. Nuttall, a few years later, supports the same view. In 1837, Dr. S. Cabot, Jr. (Journ. Bost. Soc. Nat. Hist., Vol. II, p. 126), while considering the two birds identical in species, reverses the order, making the red plumage the old and the gray the young, and in confirmation of his views exhibited as seeming conclusive evidence, an old red bird which he shot while in the act of feeding some gray young, which he also exhibited. In July of the same year, Dr. Ezra Michener, in a paper (Phila. Acad. Nat. Sci., Vol. 7, p. 53) entitled, *A few Facts, in Relation to the Identity of the Red and Mottled Owl,* states that he had seen young Screech Owls, accompanied by their parents, after leaving the nest, of both red and gray colors, the parents being always of the same color as the young. "The conclusion is, therefore," he says, "evident, either that the color of both old and young is variable or uncertain, or that they are specifically distinct." The latter opinion he adopts, ignoring the then sole known case of different colors in the young and parent exhibited by Dr. Cabot, very positively concluding that there are *two* species, and that Wilson was right.

Dr. P. R. Hoy, in his *Notes on the Birds of Wisconsin* (Proc. Phil. Acad. Nat. Sci., 1853, Vol. 6), gives them as two distinct species, while Cassin, in his various papers on the owls, adopts the conclusion of Bonaparte; considering them as one species, and the gray the adult." [1]

[1]Am. Nat., II, 1866, 327-328.

Again, Dr. W. Wood (Am. Nat., Vol. II, 1868, p. 371), mentions two cases:—the one, a Mottled Owl, taken from the nest with one young, neither of which had a red mark on them; the other, a Red Owl, taken with four young, all red. His deductions are, that there are two adults, one red without a gray feather, the other gray without the slightest trace of red; also, that there are young of each before they are able to fly, one gray and white without a red feather, the other with a reddish tinge to all the feathers. These facts he is unable to reconcile, unless, as he says, "It is admitted that the color of the plumage is either 'vaiiable or uncertain,' or else there are two distinct species as described by Wilson."

The whole is admirably summarized and described in Baird, Brewer and Ridgway (Vol. III, 1874, p. 51), in the following words, "That these two very different plumages are entirely independent of age, sex or season, and that they are purely individual there can be no doubt, since in one nest there may often be found both red and gray young ones, while their parents may be either both red or both gray, the male red and the female gray, or *vice versa*. Occasionally specimens are exactly intermediate between these two plumages, it being difficult to decide which predominates."

This difference in plumage has been termed Dichromatism, and while a hundred and twenty-five years have succeeded in establishing the fact that the red and gray screech owls are one and the same species, no satisfactory theory known to the writer has been advanced as to what dichromatism is due in this case or as to the possible causes governing it.

Naturally enough, this is far from satisfactory, while the opinions of various authors just quoted, and which comprise the most of what has been written upon the subject, tend but to raise innumerable queries for which there appear to be no satisfactory answers. Why, for instance, is the gray form dominant in one part of the country and the red in another? Why are both forms equally common in a third? Why is the red phase peculiar to the eastern members of the genus, while in the western forms it is unknown? Above all, why, at the northern boundary of *asio* proper, is the red form entirely

absent, while at the southern limit it is greatly in the majority? These and many other questions of equal importance present themselves, and but confuse and leave the reader more than ever in the dark.

While collecting screech owls in the District of Columbia during the winter of 1890–91, these questions arose very forcibly, and upon investigating, I found that while the matter was apparently settled to the satisfaction of ornithologists, as regards the identity of the two forms, nothing further appeared to be known about it. Further investigation showed that dichromatism is principally confined to the typical form of *Megascops asio*, appearing but slightly in the Florida form (*Megascops a. floridanus*), and barely reaching the Texan subspecies, *mccallii*. The remaining members of the group, four in number,[1] remaining true to their normal color.[2]

Three phases of plumage were clearly defined—the red, the gray, and the intermediate (the last less frequently seen than the others). Three distinct phases, represented indiscriminately by individuals of one species, regardless of age, sex or season! Such an unusual circumstance that the possibility of some great and important change gradually taking place at once suggested itself, which has been proved to be in reality the case.

An attempt will be made to show, first, that while the red, the gray and the intermediate phases are at present but individual variations of the same species—the gray was the ancestral stock; second, that from the gray bird has evolved the red, which at some future time will be a recognized sub-species with a range peculiar to itself, and thus dichromatism is one step in the evolution of the Screech Owl, while the various phases exhibited are the transitorial stages of development of one species from another; third, that this condition of affairs is influenced by four powerful factors (two of which

[1] Three sub-species recently described by Brewster (Auk, Vol. VIII, 1891, 139–144) would make the number seven, but these are not as yet admitted to the check list.

[2] *M. a. kennicottii* exhibits a dichromatic phase, but it is a decided dark brown, and not a reddish phase, and is not included in the present treatise.

temperature and humidity, are dominant powers in geographic distribution), the most potent of which is temperature; fourth, that the *predominating* distribution of the respective colors is largely confined to the faunal divisions of the Eastern United States, and as such is approaching the sub-specific differentiation of the two phases; lastly, that the Darwinian theory of 'Reproduction with variation and the survival of the fittest,' is well exemplified in our common little *Megascops asio*.

The Screech Owl has been made the subject of investigation simply because it offers one of the best known examples of dichromatism: if explained and disposed of in one case, much light will be thrown upon the same problem relating to many forms of animal life.

To begin with, a short description of the young, together with the manner of attaining the adult plumage of both phases, may be of service to many not thoroughly acquainted with the species. When first hatched they are covered with pure white down, which in a week or ten days begins to show faint traces of transverse dusky bars. At the age of four weeks they are fully barred with gray and white alternately, which markings they retain until the appearance of the first full plumage. As a usual thing, those destined to be red assume a rufous cast in the down shortly before the appearance of the feathers, but this is not always the case, as instances are known where the first intimation of red was the appearance of a rufous feather pushing its way through the gray or mottled down. Such instances, however, are rare, and but few are known to the writer. At the period when feathers first appear, the future color of the young bird is settled beyond a doubt; both the gray and the red birds rapidly attain their mantle, and the colors once assumed are never changed. Much confusion has arisen from the fact that some observers apparently make no distinction between the bird in the gray or mottled down and the gray or mottled plumage and upon the appearance of the red feathers through the gray down, the assertion has been made that the gray feathers changed to red. The gray birds, on the other hand, attain

their plumage at precisely the same time and in the same manner as the reds, only that their feathers are gray instead of rufous. If the above simple facts are borne in mind, no trouble need be experienced in undertanding the appearance of the two plumages.

The first step in the work was to ascertain the relative proportion of the red and gray phase in every section of the area covered by the *asio* group of *Megascops* affected by dichromatism. For this purpose nearly one thousand copies of the circular letter referred to in the introduction, were sent to the ornithologists distributed over this territory. Over two hundred replies were received, a few of which failed to be sufficiently explicit to make their contents available, but enough were obtained to compile in a reasonably accurate manner the map showing the distribution of the two color phases (map 2).

On the northern border of the range of *Megascops asio* where gray is the only form known (see map 2), correspondents from southern Ontario state that at occasional rare intervals a red specimen has been taken *in the spring*; all these birds were taken close to Lakes Erie and Ontario—while at Toronto, one pair composed of a gray and red have been known to breed, which necessitates considering the red phase in Ontario. McInraith states that the species is migratory there, to a certain extent, and it is probable that some of the red birds may be chance visitors that have come north with others. With this exception the gray belt is unbroken from Picton, Nova Scotia, through New Brunswick; northern Maine, New Hampshire, Vermont and New York; the southern part of Quebec and Ontario; northern Michigan and Wisconsin; a strip through central Minnesota, thence south-westward across Dakota and most of Nebraska, and ending in a long point near Leavenworth, Kansas. On the south this gray belt is somewhat broken as shown on map 2; in the future more complete data may show it as unbroken here from east to west as it is on the north. Beginning at a point near St. Augustine, in Florida, it encompasses nearly the whole of that state and much of the range of the Florida form, *Megascops a. floridanus*; runs northward and westward to Eufaula in

Alabama, and terminates near Mobile (this terminal point is arbitrary); while in Texas it is resumed in the southwestern portion of the range of *mccallii*.[3]

Next to this belt comes that wherein both phases occur, but where the gray predominates. It begins near Belfast, Maine, follows the exclusive gray belt with irregular outline to its termination in northern Kansas, and continues southward in a broad belt into Louisiana, where it is a question whether or not it becomes broken at New Orleans. Immediately north of New Orleans it begins again at Mandeville, La. (based on specimens in Am. Museum), and continues eastward to the coast in the neighborhood of Savannah. In its northern half it sends a long arm southward, through eastern Massachusetts, into central Rhode Island and Connecticut, again in Western Pennsylvania, it reaches in a narrow strip far down the Alleghanies into Virginia and West Virginia, terminating near latitude 37°, covers practically the whole of Ohio, with a good share of Indiana, and continues thence to Leavenworth, Kansas, the delta of the Mississippi, and to the Atlantic.

Within this area lies the region in which both forms occur, but in which *red* largely predominates (which in turn includes the exclusive red areas), and which occupies nearly one-half the area inhabited by *asio* proper. It of course conforms to the outline of the last described belt, and extends along the entire Atlantic coast from New England to Savannah.

Lastly are the two areas where *red* is the exclusive form. The one of considerable size and importance based upon substantial evidence, lies wholly within the Mississippi Valley: the other, a small strip, extends from a little northwest of Oakdale, North Carolina, to Variety Mills, in Virginia, and including Wytheville. At present the grays are apparently unknown from these areas. It has been impossible to examine material from either, and to those who may have the opportunity, I would point out the desirability of collecting all the specimens possible.

[3] The intermediate region is mapped upon very insufficient data, it being next to impossible to learn anything of this territory, but the best has been done that was possible under the circumstances.

The following table shows the data arranged by states, upon which the map (No. 2) of color distribution is based. The original letters had to be consulted in many cases as to the proper placing of the lines marking the several divisions; the table itself shows but two things: the areas where reds or grays are the exclusive form known, and where each predominates in the mixture of the two; the finer distinctions it is of course impossible to show in tabular form.

It will be remembered from quotations at the beginning, that the young produced by parents of different colors were said to be either all red, all gray, or both; that those produced by parents both of which were *red* were the same; this much is true, *but not a single record can be found of the offsprings of a pair of gray birds showing the slightest trace of red.* That the grays invariably breed true even in a region where red is the predominating color, *and where the individuals in question may themselves be the offspring of red parents,* is of itself a strong point in support of the theory that the gray was the ancestral color. Further, taking into consideration that there are certain areas where a red bird is unknown, it is evident that the grays do certainly produce young the color of their parents; and that where we take the red birds over a very large area and find them continually producing gray birds *together* with red, and compare them with the gray birds which *never* produce a red; it would appear that the gray bird was the original stock, and that the red was an offshoot—a branch, so to speak, which, owing to certain climatic conditions, or certain elements in the environment, gave it the supremacy in the struggle for existence, and that the producing of gray birds by red parents is an evident tendency to revert to ancestral characters. Nor is that old maxim in natural history, *natura non facit saltum* to be ignored; that natural selection played and is playing an important part in the matter is evident, else how came that area in which the grays are entirely absent? That the red birds were a 'sport,' or a freak, and suddenly acquired their characters, is not to be supposed for a moment; but on the theory of 'reproduction with variation' and 'natural selection,' I hold that some slight deviation from the parent stock did at one

TABLE SHOWING DATA BY STATES, UPON WHICH MAP OF COLOR DISTRIBUTION IS BASED.

State.	Red.	Gray.	Source of Information.
Alabama.		Eufaula.	E. L. Brown.
Arkansas.	Cerro Gordo.		Chas. A. Strawn.
	Clinton.		Mrs. Lillie Pleas (Oologist, VIII, 1891, 195).
Connecticut.	Portland.		Jno. H. Sage.
		East Hartford.	Willard E. Treat.
Delaware.	Wilmington.		Walter D. Bush.
Florida.		Palatka.	Jas. Sands.
		Thonotosassa.	W. H. Steacy.
		Citronelle.	Wm. H. Jeremiah.
Georgia.		Faceville.	W. B. McDaniel.
Illinois.	Mt. Carmel.		R. Ridgway (Nat. Hist. Surv. Ill., I, 1889, 417.)
	Odin.		C. B. Vandycook.
	Jacksonville.		Chas. W. Tindall.
	Warsaw.		Chas. K. Worthen.
	Rockford.		J. E. Dickinson.
	Glen Ellyn.		B. T. Gault.
Indiana.		Camden	Trans. Ind. Hort. Soc., 1890, 52.
	Terre Haute.		Trans. Ind. Hort. Soc., 1890, 52.
		Dunreith.	C. E. Pleas.
	Richmond.		Mrs. Lillie E. Pleas.
	Indianapolis.		Fletcher M. Noe.
Iowa.	La Porte City.		Geo. D. Peck.
		Sioux City.	Dr. Guy C. Rich.
	Grinnell.		Lynds Jones.
Kansas.	Argentine.		G. E. Stilwell.
		Manhattan.	D. E. Lantz.
Kentucky.		Ellis.	Dr. Louis Watson.
	Morganfield.		C. J. Lemen.
	Garrard Co.		G. V. Young.
	Versailles.		L. O. Pindar.
	Bell.		Carrington C. Bacon.
Louisiana.	New Orleans.		Gustave Kohn.
		Mandeville.	Collection Aus. Mus. Nat. Hist.
Maine.		Bangor.	Harry Merrill.
Maryland & Dist. of Columbia.	Washington.		A. E. Colburn.
	Washington.		Wm. Palmer.
	Washington.		C. W. Richmond.
	Washington.		J. D. Figgins.
	Washington.		E. M. Hasbrouck.
	Sandy Spring.		James P. Stabler.
	Laurel.		Geo. Marshall.
Massachusetts.	North Stoughton		C. A. Rummey.
		Boston.	Wm. Brewster & E. W. Ricker.
	Holyoke.		W. F. Lamb.
	Taunton.		A. C. Bent.
Michigan.	Grand Rapids.		Stewart E. White.
	Kalamazoo.		Morris Gibbs.
		East Saginaw.	Peter Lepp.

STATE.	RED.	GRAY.	SOURCE OF INFORMATION.
Minnesota.	Rochester.		W. D. Hurlbut.
		Lake City.	E. A. Wise.
Mississippi.	Waverly.		G. V. Young.
Missouri.	Fayette.		J. W. Kilpatrick.
		Butler.	Harvey Clark.
		Independence.	Charles W. Tindall.
Nebraska.		Ong.	Joel Nelson.
	London.		Geo. A. Coleman.
New Hampshire.		Milford.	J. P. Melzer.
	Webster.		Charles F. Goodhue (F. & S., VIII, 113).
New Brunswick.		New Castle.	Phillip Cox.
New Jersey.	Morristown.		Specimens in Am. Mus. Nat. Hist.
New York.		Albany.	B. W. Arnold.
		Oneida Co.	B. W. Arnold.
		Lowville.	C. Fred. Boshart.
		Lockport.	J. L. Davison.
		Owego.	J. Alden Loring.
		Binghampton.	Willard N. Clute.
		Port Byron.	E. M. Hasbrouck.
North Carolina.	Oakdale.		Robt. J. Thompson.
	Weaverville.		J. S. Cairns.
	Raleigh.		H. H. & C. S. Brimley.
Nova Scotia.		Pictou (?).	Prof.A.M.McQuarrie & Prof.McCulloch
Ohio.		Ney.	Jno. O. Snyder.
		Hamilton.	Geo. Harbron & Dr. F. W. Langdon.
		Canton.	R. H. Bulley.
	Cincinnati.		John. W. Shorten (Jour. Cin. Soc. Nat. Hist., VIII, 1885, 52).
		Lebanon.	Raymond W. Smith.
		Salineville.	Wm. A. Savage.
Ontario.		Plover Mills.	Robert Elliott.
		Lansdowne.	C. J Young.
		Yarker.	John Ewart.
		Danville.	Dr. G. A. McCallum.
		Hamilton.	T. McIluraith.
		Bradford.	A. C. Sloam.
		Listowell.	Wm. D. Kells.
		Annan.	A. C. Sloam.
		Ardtrea.	John Blair.
		Toronto.	James R. Thurston.
		Belleville.	James T. Bell.
Pennsylvania.	Philadelphia.		Chas. A. Voelker (Proc. Del. Val. Orn. Club, I, '90–'91, p. 12).
	Williamsport.		August Koch.
		Scranton.	Arthur B. Williams, Jr.
Rhode Island.		Providence.	Chas. E. Doe.
	Pawtucket.		H. A. Cash.
		Providence.	H. A. Cash.
South Carolina.	Mount Pleasant.		Arthur. T. Wayne.
	Beaufort.		Walter Hoxie.
Tennessee.	Duck River.		J. B. Cathey.
	Tazewell.		B. F. Schultz.
Texas.		Giddings.	J. O. Singley.
		San Antonio.	H. P. Attwater.
		Gainesville.	G. H. Ragsdale.

State.	Red.	Gray.	Source of Information.
Texas.	Tyler.		W. L. McDaniel.
		Travis Co.	Chas. D. Oldright.
Vermont.		East Berkshire	G. B. Hopkins.
		Strafford.	Chas. P. Collins.
		Lunnenburg.	W. E. Balch.
		Castleton.	A. O. Johnson.
		St. Johnsbury.	Franklin Fairbanks.
Virginia.	Variety Mills.		H. M. Micklem.
	Wytheville.		John B. Barrett, Jr.
		Eagle Rock.	J. T. Paxton.
		New Market.	Geo. M. Neese.
West Virginia.	Charlestown.		B. W. Mitchell.
		French Creek.	Earle A. Brooks.
		White Sulphur Springs.	Thaddeus Surber.
Wisconsin.	Madison.		Chas. F. Carr.
	Madison.		Wisconsin Nat. Vol. I, 188.
	Racine.		Dr. P. R. Hoy.
	Jefferson.		Ludwig Kumlein.
		Pewaukee.	B. F. Goss.

time occur, which in some way better fitted the individual for the struggle for existance. Through countless generations this has been perpetuated by the inter-breeding of those possessing it, in consequence, the grays, as has been seen (see map), have entirely disappeared in at least one portion of the country, and have become extremely rare in others. Many difficulties exist, both in showing the original condition, and in explaining the present state of affairs. In early scientific work, as is well known, no attention whatever was paid to matters of this nature, consequently it is impossible to ascertain the proportion of red and gray birds at a period say four hundred years ago—still, I hope to reason by analogy. As for the possible causes influencing the change, they will be found fully treated in their proper place; at present the theory is either to be proved or disproved.

Assuming that the gray was the ancestral stock, and that the producing of gray birds by red parents is a tendency to revert to ancestral characters, an analogous case will be found in Darwin's own experiments.

As is well known, many of these were performed with pigeons, which proved to be the best subjects, and the following is quoted from the "Origin of Species:"[1]

[1]Origin of Species, pp. 17–19.

"Great as are the differences between the breeds of the pigeon, I am fully convinced that the common opinion of naturalists is correct, namely, that all are descended from the rock pigeon, *Columba livia* * * * * * The rock pigeon is of a slaty blue with white loins, * * The tail has a terminal dark bar, with the outer feathers externally edged at the base with white. The wings have two black bars. * * Now in every one of the domestic breeds, taking thoroughly well bred birds, all the above marks, even to the white edging of the outer tail feathers, sometimes occur perfectly developed. Moreover, when birds belonging to two or more distinct breeds are crossed, none of which are blue or have any of the specified marks, the mongrel offspring are very apt suddenly to acquire these characters." (If this be true of distinct species, how much more is it true of different color phases of the same species). "To give one instance out of several I have observed: I crossed some white fantails, which breed very true, with some black barbs—and it so happens that blue varieties of barbs are so rare that I never heard of an instance in England, and the mongrels were black brown and mottled. I also crossed a barb with a spot, which is a white bird with red tail and red spot on the forehead, and which notoriously breeds very true; the mongrels were dusky and mottled. I then crossed one of the mongrel barb-fantails with a mongrel barb-spot, and they produced a bird of as beautiful a blue color, with the white loins, double black wing bar, and barred and white edged tail feathers, as any wild rock pigeon! We can understand these facts, on the well known principle of reversion to ancestral characters, if all the domestic breeds are descended from the rock pigeon."

Now if this reversion to ancestral characters occurs in breeds so far removed from the parent stock and from each other—how much more is it reasonable to suppose that a color phase of the screech owl, when found continually producing gray birds, while gray birds produce grays alone—is but a repetition only between birds more closely related, of the same performance?

(*To be continued.*)

THE CINNAMON HARVEST-SPIDER AND ITS VARIATIONS.

By Clarence M. Weed.

In his monograph of the Phalangiidæ, published[1] in 1868, Dr. H. C. Wood described a well-marked harvest-spider as *Phalangium ventricosum.* The description was drawn up from a single female taken near Philadelphia, and specimens of a male Phalangium collected in West Virginia supposed to belong to the same species. Besides these Dr. Wood had a number of female harvest-spiders from Nebraska "which present apparently the same specific characters as the former, except that the legs are a little shorter. Suites of specimens from the two localities would however probably show them to be distinct."

In the same paper, Dr. Wood described as *Phalangium formosum* another well-marked form found in spring.

Aside from a mention in 1869 by Dr. Packard in his Guide to the Study of Insects (p. 657), and a bibliographical reference in 1885 by Professor Underwood,[2] these species appear not to have been noticed in our literature for nearly twenty years. Since then, however, I have referred to them in a number of papers.

My first mention was published in 1887[3] when I provisionally referred *P. formosum* to the genus Liobunum, and conjectured, without having seen specimens, that *P. ventricosum* also belonged to that genus. Two years later I published[4] extended descriptions of *P. formosum* referring it to Liobunum "with considerable hesitancy, as it does not strictly belong there on account of the projecting inner angle of the palpal patella."

[1]Comm. Essex Institute, Vol. VI.

[2]Can. Ent., XVII, 169.

[3]Amer. Nat., XXI, 935.

[4]Bull. Ill. St. Lab. Nat. Hist., III, 91.

These forms were next discussed in my paper on "The Harvest-spiders of North America,"[5] in which *P. ventricosum* is definitely placed in Liobunum, and *P. formosum* together with a southern form not before described is referred to the new genus Forbesium. The new form is named *F. hyemale.* "The former (*F. formosum*) is a distinctly northern species, ranging from New York to Colorado, while the latter (*F. hyemale*) is evidently its southern representative."

Finally in the AMERICAN NATURALIST for September, 1892, I announced that by keeping specimens of *F. formosum* taken in early spring in vivaria, I had determined that it was the immature form of *L. ventricosum*; and about the same time I published[6] extended descriptions of adults of both sexes of *L. ventricosum.*

For the purposes of the present study I have had a considererable number of adult specimens from nine widely separated states, viz.; Maine, New Hampshire, New York, Ohio, Michigan, Illinois, Nebraska, North Carolina and Mississippi. Besides the adults I have had an immense number of the immature form (*formosum*) and a few of the form at present called *F. hyemale.*

The first glance at the adult specimens shows that there is a great variation in the size of the body and length of legs in different localities. The Mississippi forms are twice as large as those from New Hampshire; while those from the states between present intermediate sizes. This is shown by the measurements in millimeters in the following table; numbers 1 to 6 are males, and 7 to 12 females.

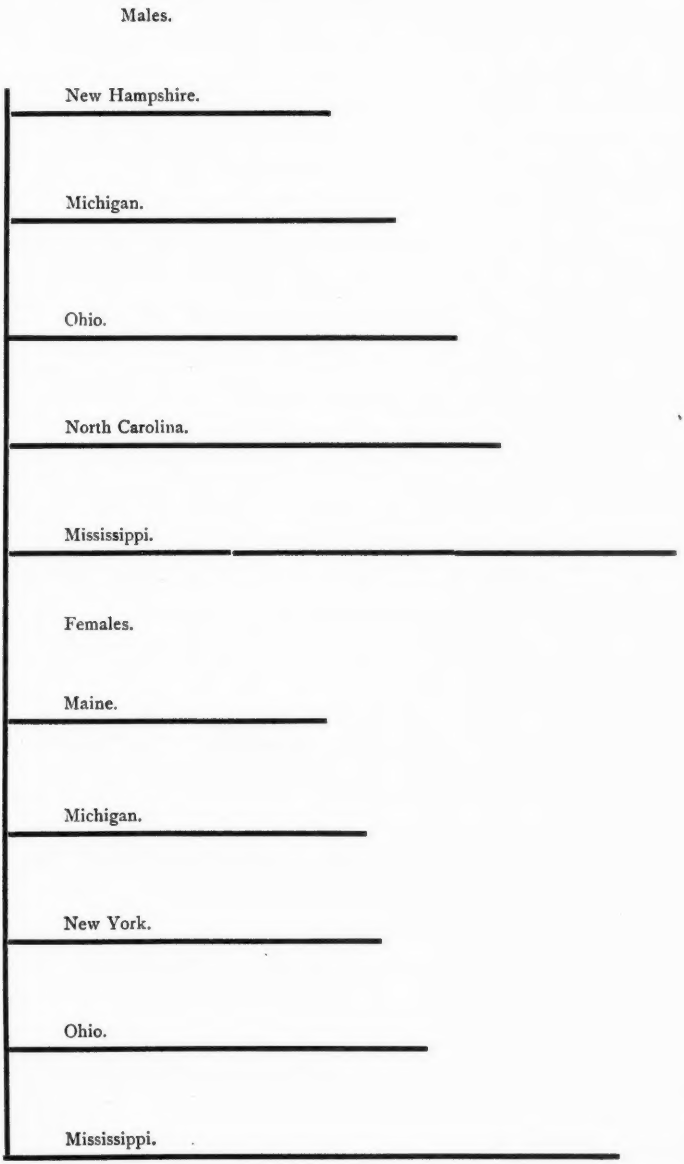
To show graphically the gradual lengthening of the legs of this harvest-spider as it goes southward I have reduced the length of the second pair, as given in this table, to the straight lines reproduced on the opposite page. The Mississippi specimens were taken at the Agricultural College in the central part of the state. I regret that I have not more specimens from the region between Ohio and Mississippi to show the transition more completely.

[5]Am. Nat., Oct., 1890.

[6]Trans. Am. Ent., Soc., XIX, 188.

Table I.—Variations of *Liobunum ventricosum.*

Number of Specimen.	Locality	Body.		Legs.			
		Length	Width	First	Second	Third	Fourth
1	New Hampshire	5.8	4.	27.5	47.5	28	36.5
2	Michigan	7.	4.4	27.5	55.5	26	42.
3	"	7.1	4.2	28.	57.5	29	44.6
4	Ohio	7.6	5.	36.5	67.5	36	——
5	North Carolina	8.	5.	44.	74.	—	——
6	Mississippi	9.	6.	52.	101.	50	73.
7	Maine	9.	5.6	25.	47.	24	——
8	New York	10.2	5.5	27.8	55.	27	39.
9	Michigan	10.	6.	28.	53.	28	40.
10	Ohio	10.	6.	——	62.	—	48.6
11	Mississippi	13.4	7.	46.	89.	44	——
12	"	11.	6.2	48.	93.5	46	68.


Males.
New Hampshire.
Michigan.
Ohio.
North Carolina.
Mississippi.
Females.
Maine.
Michigan.
New York.
Ohio.
Mississippi.

Like other harvest-spiders this species also varies considerably in a given locality. It is so rare that it is difficult to get long series from one place so that I cannot tabulate at present these variations as fully as has been done for *Phalangium cinereum* and *Liobunum vittatum dorsatum.*[7] To indicate the variation that sometimes occurs in a single state I may record that of two specimens from Dover, New Hampshire, measured since the above tables were prepared, the body of the male was 8 mm. long, and the second legs 63 mm., while the body of the female was 10 mm. long, and the second legs 50 mm. The second legs of this male specimen were 15.5 mm. longer than the one from Hanover recorded in the table. It should be stated however that Dover is distinctly within the region of the Alleghanian fauna, and Hanover is on the border between the Alleghanian and Canadian faunas.

A study of all the specimens of my *Forbesium hyemale* now accessible leads to the conclusion that this is the immature stage of the southern form of *L. ventricosum*, just as Wood's *P. formosum* is the immature stage of the northern form of this species. The dissection of specimens shows that they are not

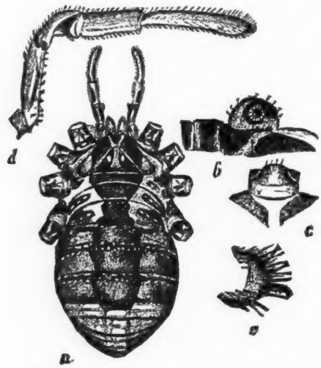


FIGURE 1.—*Liobunum ventricosum.* Immature: *a*, body; *b*, eye eminence, side view: *c*, same, front view; *d*, palpus; *e*, palpal claws; all magnified.

sexually mature, and the dates of capture indicate that they disappear late in spring or early in summer at the time the

[7] AMERICAN NATURALIST, Vol. XXVI, pp. 34–36.

adult *L. ventricosum* appear. This is precisely the condition in the northern states. An idea of the similarity of the two immature forms in structural details may be obtained by comparing Fig. 1 with Plate XIV, Fig. 2.

The southern form of *L. ventricosum* should evidently be considered a geographical race sufficiently distinct for subspecific name. Inasmuch as *hyemale* has already been applied to the stage immediately preceding the adult it may well be used for this race, and the form be known as *Liobunum ventricosum hyemale.* Just where the line dividing the two forms should be drawn is difficult to say without more material, but it probably occurs near the latitude of southern Ohio.

Laws of Variation in Harvest-spiders.

Comparatively little definite investigation of the geographical variation of North American invertebrates has yet been undertaken. In the vertebrates—especially birds and mammals—much attention to the subject has been given by Baird, Allen and other well-known zoologists, so that a number of general laws have been formulated.[8] To determine to what extent these laws hold true for the invertebrates, as represented by the Phalangiidæ, I have ventured to formulate some of the results obtained in my studies of this group—results which in part have already appeared in the Naturalist and in part are yet unpublished. At the present stage of investigation such formulæ cannot be considered as final by any means, but if they serve no other purpose they will be useful in determining the direction of future work.

(1.) In mature individuals of the same species and sex from a given locality there may be found a decided variation in size of body and length of legs. In a series of fifty or a hundred such individuals taken at random the body of the largest specimen will usually be from one-fifth to one-fourth longer than that of the smallest; and the legs of the longest-legged individual are likely to be from one-fifth to one-third longer than those of the shortest-legged specimen.

[8]See the American Naturalist, Vol. XXVI, pp. 87–89.

(2.) As a rule, not without exceptions, the legs vary together in a given direction; that is, if in a certain individual the first pair are longer than the first pair of another individual, the other legs of the former are likely to be longer than the corresponding legs of the latter. The hind legs are the most irregular in their variation.

(3.) There is a gradual increase in size of body and length of legs in the individuals of a species from the north, southward at least as far as latitude 37° in the Mississippi Valley near which region the sub-family Phalangiinæ appears to attain its maximum development.

(4.) The proportionate increase in the length of the legs to the southward appears to be greater than that of the body.

These last two propositions are true of all the harvest-spiders having an extended northern and southern distribution studied with reference to their variations, viz; *Liobunum vittatum, L. ventricosum, L. politum* and *L. longipes.* Probably the most important factor in determining this increase in size is to be found in the climatic conditions which permit a longer period of growth and feeding at the south than in the north. The arachnids undergo no definite series of molts, simply casting their skins as increase in size requires. Such climatic conditions, combined presumably with a more abundant food supply, may tend, apparently, to increase the size of these harvest-spiders by at least three methods:

(*a.*) By the direct effect of a long warm period of growth with abundant food upon the individual before attaining its full size.

(*b.*) By the effect of a long period of development of the eggs in the ovaries of the female.

(*c.*) By the action of the eliminating principle in natural selection in fostering those individuals which attain the maximum size compatible with their environment.

This increase in size of individual may possibly be of benefit to the species (1) by enabling it to prey upon larger insects, thus increasing the source and variety of its food-supply; (2) by enabling it better to elude predaceous enemies, or (3) to catch fleeing prey.

PLATE XIV.

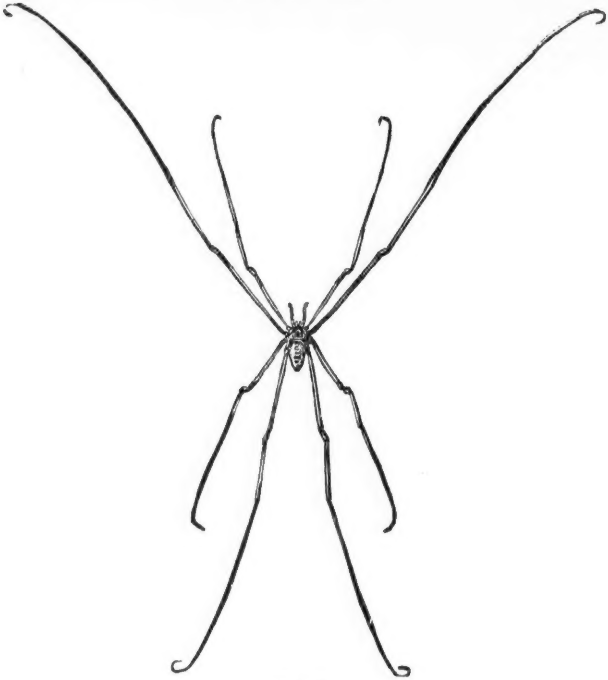


FIG. 1.

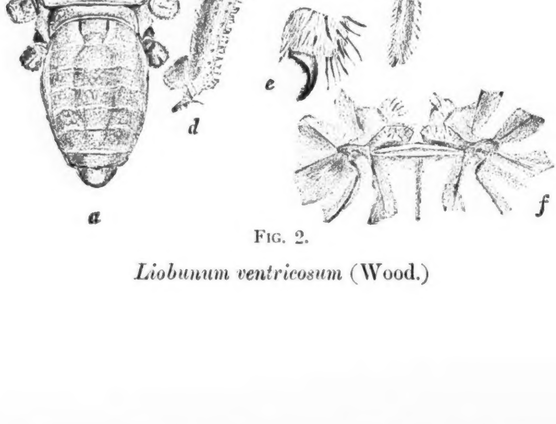


FIG. 2.

Liobunum ventricosum (Wood.)

(4.) In the plains region of the Northwest (Dakota, Nebraska) the legs are considerably shorter than in similar latitudes in New England.

For example, the second legs of a male *Liobunum longipes* from Brookings, South Dakota, measure 62 mm., while those of a Hanover, New Hampshire specimen measure 74 mm. The case of the Striped Harvest-spider (*L. vittatum dorsatum*) is still more striking; the second legs of a New Hampshire specimen measure 71 mm., while the normal length in South Dakota seems to be only 35 mm.

In addition to the above the following laws of vertebrate variation appear to hold good in the Phalangiidæ.

(5.) "The maximum physical development of the individual is attained where the conditions of environment are most favorable to the life of the species.

(6.) "The most typical or most generalized representatives of a group are found near its center of distribution, outlying forms being generally more or less aberrant or specialized."

Explanation of Plates.

Plate XIII. Fig. 1.—*Liobunum ventricosum* (Wood), male. Natural size.
" 2.—Parts of same. Magnified.
" 2*a*.—Body.
" 2*b*.—Eye eminence. Side view.
" 2*c*.—Eye eminence. Front view.
" 2*d*.—Palpus. Side view.
" 2*e*.—Claw of palpus. Side view.
" 2*f*.—Maxillary lobe of second pair of legs.

Plate XIV. Fig. 1.—*L. ventricosum hyemale.* Immature. Natural size.
" 2.—Parts of same. Magnified.
" 2*a*.—Body.
" 2*b*.—Eye eminence. Side view.
" 2*c*.—Eye eminence. Front view.
" 2*d*.—Palpus. Side view.
" 2*e*.—Claw of palpus. Side view.

EDITORIALS.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

—We have received from the Secretary of the American Philosophical Society, a programme of the exercises on the occasion of the celebration of the 150th anniversary of the foundation of the Society. The celebration commences on Monday, May 22d, at 8 P.M., and continues until Friday the 26th inclusive, and consists of sessions commencing at 11 o'clock A.M., excepting on Monday, when the session opens at 8 o'clock, P.M.

The programme is the work of a committee, and was not submitted to the Society until its terms could not be altered without discourtesy to the persons who had been invited to participate in it. This much is due to the Society, since it is, under such circumstances, not responsible for the committee's work. As to the committee, its work is disappointing, for since there is one member of it who is presumably competent for the work it undertook, he should have been able to so influence the other members as to have produced a widely different result. The adoption of such a programme is to misrepresent the position which Philadelphia holds in the wide field of labor covered by the Society, since it does not include any paper or address by any one of its citizens presenting his own original work in art, science or philosophy. On the contrary, the best that can be said of the programme is that its subject-matter, so far as contributed by Americans, consists of those generalities to which popular assemblies are wont to be treated, and, perhaps, entertained, if not satisfied. For a Society whose fundamental object is the "increase of knowledge," to occupy its time in platitudinous disquisitions of this kind, displays a misconception of its own position and, a lowering of the standard of achievement which it is of all the societies in this city called upon to bear.

When an active Society, such as the one in question, celebrates an anniversary of significance, it usually presents to the world some evidence of its activity by securing for the occasion the services of such of its members as are competent so to do. Such occasions are usually selected for the announcement of the results of their work before the wider audience which the occasion is expected to attract. A memorial volume of permanent value is the usual result.

As an illustration, in 1880, the Boston Society of Natural History celebrated the fiftieth anniversary of its foundation. A memorial volume was issued, which includes the papers read on that occasion, and it is a monumental work. The same course should have been pursued by the American Philosophical Society. There is no deficiency of workers or of work. The members of this Society produce *original work* in Prehistoric Archeology, Philology and Ancient and Modern History; in Chemistry, Geology Biology; in Political Science, and in pure Philosophy. We emphasize the words *original work.* That none of these men and none of this work appear in the programme will be cause of astonishment both in Philadelphia and out of it.

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RECENT LITERATURE.

Evolution of the Colors of North American Land Birds.[1]—This octavo of 361 pages, published by the California Academy of Sciences, the author Mr. Charles A. Keeler, modestly calls a study. The views set forth are more or less provisional and tentative, and are intended to direct research into this new field of ornithological inquiry. The subject-matter of the essay is preceded by a discussion of the various views held as to the laws conditioning evolution, such as inheritance of acquired characters; the nature of species; natural and sexual selection, and isolation, as factors in the evolution of species. In concluding this rather lengthy introduction, the author remarks " that life has evolved in accordance with tolerably definite and unvarying laws, and that the element of chance, if any such there be, is a very limited one."

In Part II the colors of North American birds, are treated of under the following heads: Modes of plumage changes; General principles of color in Birds; The proportion and distribution of the colors in the North American genera; The pattern of markings; Variation of color with sex, age and season; The direct influences of the environment; Geographical distribution as a factor in the evolution of colors; Orders, families and genera of North American Birds, considered from the stand-point of their evolution.

The theory of bird colors which Mr. Keeler seeks to establish is as follows: Pigment is a chemical composition thrown off from the system of the bird, probably as a product of waste, and lodged in the integument. The chemical substance thus generated varies in different groups of birds, but is probably generally constant in the species of one genus, or frequently in an entire family. A certain genus would thus be capable of generating only a given number of fundamental colors, but natural and sexual selection by combining and rearranging this limited assortment can produce a variety of effects.

Associated with this theory is the Law of Assortment of Pigments; that is, that the primitive color is a composite which, when more or less completely resolved into its component elements gives the specialized tints of the species or genus. If the system of the bird from which

[1]Evolution of the Colors af North American Land Birds. Occasional Papers of the California Academy of Sciences III. By Charles A. Keeler. San Francisco, January, 1893.

some of the present highly colored genera were evolved produced normally two pigments, unless some distributing force were brought to bear upon them, they would naturally be combined at first. It is only after long selection that the component colors become apparent. The examples cited are, as might be expected, among the most highly specialized genera. The woodpeckers are colored black, white and scarlet. The combination would produce brown, which is still the body color of some species. In the genus Tyrannus the original color was probably olive green, the special colors are black and yellow. In the blue jays that are blue in the adult together with black and white, the mixture of these colors gives the grays of the young, and of the less specialized forms, as Perisoreus and Picicorvus. Besides black and white, most North American genera appear to contain but two fundamental colors, but in the tropics three frequently occur in a single genus.

In discussing protective coloring, repetitive marks, and recognition marks, the most recent literature upon this subject is cited and illustrated with numerous facts of the author's own observation.

Having considered the factors that influence the evolution of colors of North American birds, Mr. Keeler gives a brief account of the families and genera with an application of the principles discussed.

Mr. Keeler's review of the factors of organic evolution is comprehensive and intelligent. He appreciates the fundamental difference between the origin of characters and the selection of characters, though occasionally he slips into the customary confusion on this point by ascribing the origin of some color marks to natural selection. The reviewer takes this opportunity to refer to one misunderstanding into which he in common with many others has fallen, in his reference to effort as prior to use in developing structure. He says (p. 75) "All that can be said to the above [the theory of effort] is that it may be true but that it has not yet been demonstrated. There is indeed a vast difference between the assumption that use can modify a part which already exists, and the assumption that desire or effort can originate something which does not exist. Moreover, even if effort be a valid factor in creation, it cannot it seems to me have the general application ascribed to it by Professor Cope. For example, it could apparently have no influence on the origination of new colors. Does the bird desire to be protectively colored? If so it must decide what colors would be most in harmony with its surroundings, and then make an effort of will to have these colors developed; all of which is on the face of it inconceivable. Or by what imaginable sort of effort could

feathers be originated? Effort then, if it can be shown to have any creative power, must be relegated to a very special field, and cannot be considered as the sole or even principal originator of the fittest."

The above paragraph indicates a radical misconception of the proposition.

Effort is simply the conscious preliminary to motion, and motion is the fundamental efficient cause of the leading modifications of structure. No knowledge or intention as to the result or effect (final cause) of the motion is to be supposed. It is motion which changes the environment of an animal, and which is thus at the bottom of whatever results from that change, let the immediate efficient agency be physical, chemical or mechanical. The psychic cause of this effort is a sensation. Of course in purely reflex acts, effort (which is assumed to be conscious by its definition), is wanting, but the hypothesis sustained in the work quoted by Mr. Keeler, (The Origin of the Fittest), is that reflex acts have had their origin in conscious acts, and are the result of automatization, which is the ordinary process of education. Reflex motions then have had their origin in effort as well as the so-called voluntary acts, but at an earlier period. For this reason they have relatively little to do with the molar movements of animals at the present time, and therefore little to do with the *present* origin of specific characters. It is present effort which precedes most of the motions of animals, and which thus has everything to do with the environment, to which evolutionists of all shades appeal as an efficient cause.

The most important contribution towards the discovery of the origin of colors in birds by Mr. Keeler, is his demonstration of the law of the Assortment of Pigments. His classification of our birds in accordance with their color relations, is a valuable preliminary to further research. When we reach the final stage of the subject, the origin of the tints themselves, no definite progress is made in the book before us. As one of the most difficult problems in organic molecular physics, it requires a very special mode of experimental treatment, and one which Mr. Keeler has not attempted. The origin of color patterns is less difficult of approach, and some progress has been made in this direction, but the subject is yet in a very primitive stage.

The illustrations of the book are numerous and often in colors, and they add greatly to its value. The work is gotten up in excellent style, and is a credit to all concerned in its publication. C.

Wright's Man and the Glacial Period.[1]—This book is the best synopsis of present knowledge of the glacial epochs and its relations to human history which has yet appeared. The compass of the work necessarily does not permit as great detail as would be appropriate to a technical monograph, but it is admirably adapted for the purpose for which it is designed, i. e., that of giving the greatest amount of information in a readable form in the smallest space. The treatment of disputed topics is generally judicial, and the author has brought to bear on the subject a great wealth of facts not only from all published sources, but also from his own original research in North America and Europe. A question of much general interest is that of the age of the great ice period. He brings together evidences from various observers to show that its close cannot have been more than 15,000 years ago, and that its duration may have been twice as long. The basis of this estimate is the rate of cutting of various post-glacial gorges, of which well-known examples are that of the Niagara River, and that of the Mississippi below the falls of St. Anthony. This shortened time is in remarkable contrast to the estimate made by the geologists who first attacked the problem.

The portion of the book relating to the antiquity of man is the smaller half, but the conclusive evidences of man's existence during the glacial epoch are necessarily local. Such evidence as this is handled judiciously, and all objections are duly considered. Professor Wright is of the opinion that some of the finds which indicate the existence of man during the glacial epoch are trustworthy evidence to that effect. He cites especially as American localities, Trenton, New Jersey, (Abbott); Newcomerstown and Madisonville, Ohio; Little Falls, Minnesota, Miss Babbitt; Nampa, Idaho, and Calaveras Co., California. These finds will be mentioned again below. He considers the supposed finds of human implements in beds of Neocene age as not established.

Dr. Wright's book has been made the object of a vigorous attack by the geologists of the U. S. Geological Survey in a way which shows an animus on their part not strictly scientific. President Chamberlin in the Chicago Dial, charged the author with improperly alleging on the title page that he was an assistant on the U. S. Geological Survey. To this Dr. Wright replied that he was so employed at the time the book was written and demonstrated satisfactorily his right to use the title assistant. One of the other criticisms was regrettably free from the amenities which should characterize scientific discussion, while others

[1]Man and the Glacial Period by G. Frederick Wright, D. D. LL. D. International Scientific Series No. LXIX. New York, D. Appleton & Co., 1892.

exaggerated unimportant details, and ignored the general value and utility of the book. To all this Dr. Wright has replied temperately and convincingly.

The ethnologists of the Bureau at Washington have made destructive criticisms of the evidence for glacial man contained in the book. Probably the most expert makers in the world of human implements of the stone age are Messrs Holmes and Maguire of Washington. They show convincingly that it is easier to make neolithic or pecked and polished stone implements, than to make fine chipped flints of paleolithic type. Hence they conclude that either the order of age should be reversed, or that paleoliths and neoliths are of con-

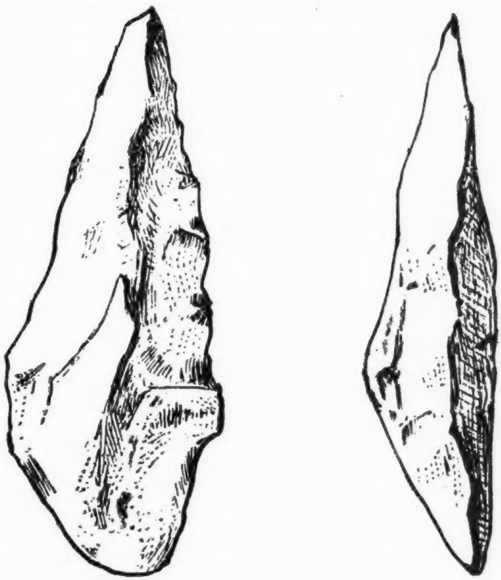

FIG. 1.

Fig. 1. Argillite implement found by Dr. C. C. Abbott, March, 1879 at K. K. Rowan's farm, Trenton, N. J., in gravel 16 feet from surface. From G. F. Wright's Man and the Glacial Period.

temporary age, and that the absence of neolithic implements from some deposits is simply due to accident or to the soft material of which such implements were made. This conclusion, if correct, revolutionizes prehistoric archeology. These gentlemen think that it should be

revolutionized, and that paleolithic man in both Europe and North America is a myth. The great collections of paleoliths of the turtle-back and Chelléen types they look upon as cores and rejects of pieces from which better implements have been made and taken away. This view leads them to look with suspicion on the alleged discoveries of glacial man, and Mr. Holmes has accordingly written articles discrediting the finds described in Dr. Wright's book.

It may be remarked apropos of the observations of Messrs Holmes and Maguire, that though it may be true that pecked and ground implements are more easily made than well chipped flints their actual relations in time can only be ascertained by stratigraphic and paleontologic research. A flint broken once or twice so as to produce an edge is more easily made than a neolith, and gives a great deal better edge, so that such implements may very probably have antedated the latter, while the finer ones are well-known to have been neolithic, and have been made up to the present day. The question is however, not which implement ought to have come first, but which actually did come first.

As regards the finds in Europe, those of the caves are the result of so much careful investigation, and are characterized by such satisfactory stratigraphic conditions, that they cannot be impeached by observations made in this country. The paleoliths and human bones have been conclusively shown to belong to the age of the glacial fauna. In North America the paleontologic evidence is not so good, but such as there is, indicates strongly that the earliest known American was not more modern than the paleolithic European. Those who saw the Calaveras skull when first found, allege that it was more or less covered with the adherent cement so characteristic of the gold bearing gravel of California. The age of this gravel is not exactly determinable, since data respecting the finding of fossils in it are not generally reliable. But that it is of approximately glacial age no one doubts. Mr. Holmes believes that the implements of the Abbott and Babbitt finds occur only in the talus, and are not from the undisturbed glacial gravels (American Geologist) ; but so far as regards part of the Babbitt, and all of the Abbott finds, other observers hold a different opinion. In the Journal of Geology he shows that the evidence for the stratigraphic position of the finds at Madisonville and Newcomerstown, Ohio, is defective. It may be added here that the Nampa image, whatever may be its real stratigraphic origin, displays in its form an artistic skill on the part of its maker, not to be looked for in primitive man ; nevertheless it is time that the name of the person who alleges

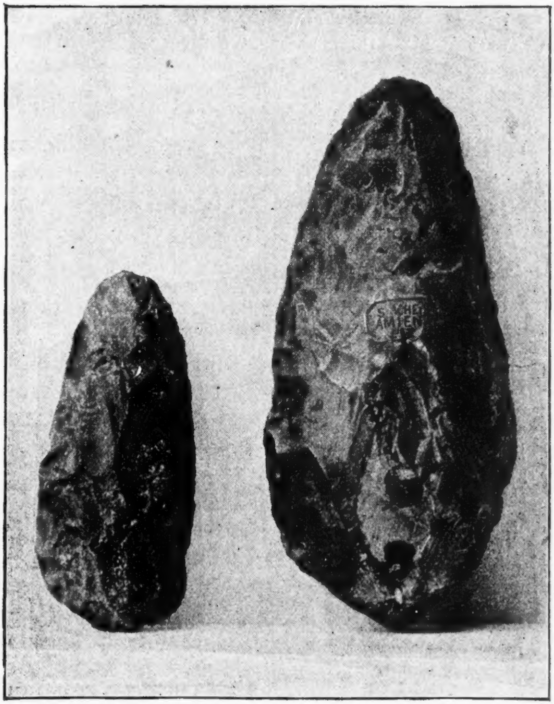

FIG. 2.

Fig. 2. Smaller figure, paleolith from Newcomerstown, Ohio; larger figure do from Amiens, France; both one-half size. From G. F. Wright's Man and the Glacial Period.

that he intentionally deceived Professor Wright in this matter, be produced; and the authority for the statement that such an assertion was made, should make himself known. The image cannot well be the work of any existing Indian tribe, as has been asserted. In any case it seems that the evidence for Plistocene man in America, must be further investigated with careful methods, and under more favorable circumstances than are furnished by most of the so-called glacial gravels.

We give figures of two characteristic types of paleoliths; one of argillite found by Abbott at Trenton, N. J.; and one flint from Newcomerstown, Ohio. E. D. COPE.

Some Recent Books on Bacteriology.—One of the most recent works dealing with the bacteria is Dr. Sternberg's[1] Manual of Bacteriology. He is well known as an investigator in this field, and is moreover one of the pioneers in the United States. The work is a most comprehensive one, the best published in the English language. While perhaps not so full on pathogenic organisms as Baumgarten's Lehrbuch der Pathologischen Mycologie, yet it is sufficiently full and complete to make it one of the best books of its kind. It moreover contains accounts of the most recent discoveries in regard to pathogenic organisms.

One hundred and one pages are devoted to history, classification, morphology and general bacteriological technology. The author adopts the classification of Baumgarten (1890) with slight modifications. He divides the species into (1) relatively monomorphous and (2) pleomorphous. Under the first micrococci, bacilli, and spirilla are grouped; under the second spirulina of Hueppe, leptotricheæ (Zopf) and cladotricheæ. Hauser's Proteus also belongs here. Part second is devoted to general biological characters; including an account of the action of antiseptics and germicides. Dr. Sternberg's work on antiseptics and germicides is so well known that it will not be necessary to refer to this part of the work at length. Three hundred pages are devoted to pathogenic bacteria, 158 species are carefully described, and many are illustrated. In some cases the colors of the growth when grown in different nutrient media are given. Botanists will be chiefly interested in the account given of the saprophytic bacteria. Chapters are devoted to the bacteria of the air and water, bacteria found in the stomach and intestinal canal, articles of food and soil, in which the usual methods of culture are given. Three hundred and thirty one species are described. This feature of the book makes it especially commendable. Those who have had occasion to use the classification of De Toni in Saccardo's Sylloge Fungorum or that of Crookshank in his Manual of Bacteriology have found the descriptions of the species far from satisfactory. The descriptions given by Sternberg are ample for the determination of the species.

The biological characters are very full. An excellent bacteriological diagnosis is a great aid in the determination of the species. A few errors have made their way into this part of the book. On page 758, *Bacillus citreus-cadaveris* is said to be motile, but turning to page

[1]A Manual of Bacteriology. Illustrated by heliotype and chromolithographic plates and two hundred and sixty-eight engravings, 886 pp. New York, Wm. Wood and Co., 1892.

633 where the species are described it is said to be non-motile. The same for *Bacillus fulvus*, which p. 758, is said to be motile, but on p. 629 is described as non-motile. Notwithstanding that a few of these defects occur, this part will certainly be appreciated by working bacteriologists. In this key the following characters are used. (1) Morphologic; Micrococci, Bacilli, Spirilla, Leptotricheæ and Cladotricheæ. Formation of spores, independent motion. (2) Physiological characters; relation to oxygen, ærobic, strictly anærobic, facultative anærobic, growth in gelatin, liquefy or do not, no growth in gelatin, growth on potato, in milk, coagulate milk, do not coagulate milk, color of growth, chromogenes, not chromogenic, pathogenesis.

The bibliography has been gotten together with great care, and is very full, containing the titles of 2,582 papers grouped under historical classification, staining methods, culture media, sterilization of culture media, etc. A very large number of papers are cited on the physiological properties, such as lactic acid fermentation, viscous fermentation, putrefaction, etc. The literature on pathogenic microorganisms is especially full. Bacteriologists should feel grateful to Dr. Sternberg for this work, and also to the publishers for the excellent manner in which their part also has been performed.

Wm. Wood & Co. have during the past four years issued two other text books on bacteriology; the English translation of Salomonsen's Bacteriological Technology, by Professor Trelease is well known and needs no introduction. A second admirable work, antedating Sternberg's Manual, is Fränkel's Grundriss der Bakterienkunde translated by J. H. Linsley.[2] It has been translated into six different languages, and those who have been fortunate enough to use the German edition know its admirable qualities. The translation before us is an admirable one. The style is clear and there is no difficulty in understanding the author. The work contains a great deal on the biology of many species that hitherto has not been found its way into English works. It is to be regretted however that references to literature are not given, but these may readily be obtained from Sternberg's Manual. No figures are given in the book, but the accounts are clear. Future editions should have figures.

For a limited amount of work both of the books noticed above are too large. One of the best of the small books with which the writer is familiar is Abbott's[3] Principles of Bacteriology.

[2]Text-book of Bacteriology, third edition, translated and edited by J. H. Linsley, pp. 376. New York, Wm. Wood & Co., 1891.

[3]The Principles of Bacteriology. A manual for students and physicians. Lea Brothers & Co., Philadelphia, 1892, pp. 263

This book is well suited for class room work. Its technique is stated in clear and concise language, accompanied with numerous illustrations. The writer having used this for a large class is prepared to say that it is an excellent work of its kind.

Another hand-book intended for a larger circle of readers is Woodhead's[4] small volume on Bacteria and their Products. It treats the subject in a somewhat different manner than the others. It gives considerable attention to historical matters, and treats quite fully the different systems of classification used by Ehrenberg, Cohn, Van Tiegham, Zopf, De Bary, Hueppe and Flügge. The chapter on fermentations contains a great deal on chemistry, but it is far from being a popular exposition of the question. The author has of course largely drawn from Hansen, Pasteur, and Schützenberger. The author uses the word parasite and saprophyte in a somewhat peculiar way. He speaks of the bacteria of the mouth as being parasites, contradicting a previous statement made with reference to parasitic bacteria. The work has been edited rather carelessly, the word "parasiticism" for parasitism occurs in several places as well as the word "saprophyticism."—L. H. PAMMEL.

Report on the Fish and Fisheries of the United States for 1888.[5]—This volume, an octavo of 902 pages, contains in addition to the Reports of the Commissioner, Hon. Marshall McDonald and his two assistants, 11 important papers bearing upon the Fish Industry. The results of the sea-coast inquiries conducted during the year 1888 are embodied in the reports of Mr. J. W. Collins and Lieutenant Commander S. L. Tanner. The work accomplished at the laboratory of Woods Holl, Massachusetts is reported on by Mr. J. A. Ryder. Notes on Entozoa of Marine Fishes, with descriptions of new species and the anatomy of *Thysanocephalum crispum* Linton are given by Mr. E. Linton.

Number 8 in the series of Appendices is a review of the Fresh-watėr Sunfishes of North America by Mr. C. H. Bollman. It is the beginning of the systematic investigation of interior waters by volunteer naturalists under the direction of Dr. D. S. Jordan. The Apodal Fishes inhabiting the waters of America and Europe are reviewed by

[4]Bacteria and their Products. The contemporary Science series, edited by Havelock Ellis, pp. 459, with 20 photo-micographs. London, Walter Scott, 24 Warwick Lane, Charles Scribner Sons, New York, 1892.

[5]U. S. Commission of Fish and Fisheries. Part XVI. Report of the commissioner for 1888. Washington, 1892.

Dr. Jordan and Mr. B. M. Davies. The work undertaken by Prof. W. O. Atwater ten years ago, viz., a comprehensive series of experiments upon the chemical composition and nutritive values of the American food-fishes, has been completed, and his report upon the subject is published as Appendix 10 to this volume. The last paper is J. W. Collins' Report upon the participation of the U. S. Fish Commission in the Centennial Exposition held at Cincinnati, Ohio, in 1888.

The numerous illustrations and maps give additional interest to this comprehensive report.

General Notes.

GEOLOGY AND PALEONTOLOGY.

Oneonta and Chemung Formations in Eastern Central New York.—The Oneonta formation comprises a thick mass of red shales and red and gray sandstones, similar in character to the rocks of the Catskill Mountains. They overlie the Chemung formation in southern New York and northern Pennsylvania. The recent investigations of Mr. N. H. Darton confirm Professor Hall's supposition that the Oneonta beds represent the eastern extension of the Portage formation. The former is characterized by a large quantity of red shale which occurs as streaks in the lower beds, a thick mass a little higher in the series, and constitutes elongated lenses in the gray flags and red sandstones of the upper member of the formation. Toward the western termination of the Oneonta formation the red material rapidly disappears and its place is taken by gray shales and thin bedded sandstone. There can be no doubt of the continuity of sedimentation throughout. Toward the east the formation increases in thickness until it comprises the lower thousand feet of beds in the Catskill Mountains. The Chemung fossiliferous shales which overlie the Oneonta formation south of Franklin grade upward through a series of flags into hard, coarse, cross-bedded gray sandstones with intercalated red shale layers. Toward the east the fossiliferous shales merge into flags, and then into hard, coarse sandstone with flaggy layers along the eastern front of the Catskill Mountains.

Since the rocks of the Catskill Mountains comprise the Chemung and Portage horizons, Mr. Darton proposes to discard the use of Catskill to designate a formation, and to use the term Catskill group to include the Chemung and Portage formations. (Am. Journ. Science, March, 1893.)

Tertiary Insects from Colorado and Utah.—Bulletin No. 93 of the Geological Survey comprises descriptions of eight species of Oligocene insects from Florissant and other points in Colorado and Utah, by Samuel H. Scudder.

Of this group of interesting fossils six are referred to new genera. In a short introduction the author gives the special claim which each

has for consideration. The Trichocemsis represents a type hitherto considered exclusively gerontogeic; the Stenogomphus is the first Gomphine fossil found in this country; the Cicada for its great size and for being the first member of its family known from American rocks; the Hymenoptera is curiously related to Oriental forms; the Diptera are interesting departures from the modern types to which they are most nearly allied; the two Coleoptera present some curious features; the butterfly is of exceptional interest as belonging to a waning type which probably flourished remarkably in Oligocene times, if the published figures are to be regarded as having any weight at all.

A Supposed New Order of Gigantic Fossils from Nebraska.—In "University Studies," published by the University of Nebraska, 1893, Mr. E. H. Barbour describes and figures a number of gigantic mineral bodies of such anomalous form and structure, that the author offers as a merely provisional classification until their place can be more definitely determined.

These fossils are found in the Miocene beds which follow the divide between the White and Niobrara rivers in Sioux County, Nebraska. They are very abundant and increase in size toward the southern limit of the beds. In appearance they resemble colossal corkscrews varying from two to nine feet in length. A transverse piece corresponding to the handle of the corkscrew, for which the term rhizome is adopted by the author, is often three feet in diameter. The fossil corkscrew is invariably vertical, while the so-called rhizome as invariably curves rapidly upward and extends outward an indefinite distance. Some of the screws coil about an axis, others are unsupported. The author is positive as to their organic origin, and is inclined to believe them to be sponges. Five microscopic slides show certain smooth spindle-shaped rods suggestive of sponge spicules, but a sixth section reveals unmistakable plant cells. A third evidence of their organic nature is the characteristic intricate network of minute silicious tubes in the stems. To add to the difficulty of the problem, a well-preserved skeleton of a rodent was found in the great stem of one specimen. This rodent is the size of a "jack rabbit," with proportionately large incisors, sagittal and occipital crests high and sharp, and a mole-like shoulder girdle.

In order to preserve the appropriate name—"Devil's Corkscrew"—bestowed by the ranchmen, Mr. Barbour calls these strange fossil forms Daimonelix.

The most probable explanation of these objects seems to be that they are the casts of the burrows of some large rodent. The horizontal portion will then be the entrance; the enlargements the position of the

nests, and the spiral vertical portions shafts for safety or escape of the occupants, or for the admission of air; the spiral being necessary for the convenient ascent of the animal. It is well known that species of Thomomys make spiral burrows; and remains of this genus are not rare in the Plistocene beds of Kansas.—C.

Mammalia from the "Pits of Gargas."—In the grotto of Gargas, not far from Montréjean, a number of pits have been found about 100 metres from the entrance. These pits are 20 metres in depth and have mouths so narrow that it is with difficulty that a man can force himself through the openings. M. Regnault has recently explored these pits and found them rich in fossil remains of bears (*Ursus spelæus*, the small variety), wolves (*Canis lupus*), and hyaenas (*Hyaena crocuta*). M. Gaudry notes the unusual circumstance of the fine state of preservation of the fossils, particularly of a hyaena and a wolf, of which almost complete skeletons were obtained. These finds have been made the subject of a joint paper by MM. Gaudry and Boule, in which they discuss the affinities of these cave animals, and give tabular statements of the genealogy of the bears and of the hyaenas. The latter differs from the one published by Schlosser in 1890.

A series of fine plates illustrates the paper. (Materiaux Pour. l' Histoire des Temps Quaternaires. Quatrième Fascicle, Paris, 1892.)

Mr. G. F. Matthew reports a new genus, Protolemus, of Trilobites from the St. John group of the lower Cambrian beds. The new genus is represented by two species, *P. elegans* and *P. parodoxoides*. (Bull. New Brunswick Nat. Hist. Soc., 1892.)

The Cleveland shale of Ohio has yielded a new Coccostean, which is described by Professor Claypole under the specific name *Coccosteus cuyahogae*. This species comes from a higher horizon than either *C. hercynius* or *C. occidentalis*, and is remarkable for its large size. (Am. Geol., March, 1893).

Paleozoic.—Mr. H. E. Sauvage has been studying the fish fauna of the Permian of France. He finds that of 24 species, 14 are, for the present, peculiar to France. This fauna is, undoubtedly, that of the Lower Permian, and is characterized by a predominance of species belonging to the genera Amblypterus. (Revue Scientifique, Avril, 1893.)

Mesozoic.—According to Chapman, the Phosphatic Chalk of Taplow, England, has yielded 5 species and varieties of Ostracoda, all previously known, and 98 species and varieties of Foraminifera, of which the following are new to science: *Nubecularia jonesiana*, *Textu-*

laria decurrens, Textularia serrata, Bulimina trigona, and *Bolivina strigillata.* (Quart. Journ. Geol. Soc., Nov., 1892).

Cenozoic.—The Pliocene fauna of Rousillon, which now numbers over 30 species of vertebrata, has recently had a second Proboscidian, *Mastodon borsonii*, added to the list of mammalia. The specimen, found near Villeneuve-de-Raho, consists of the series of upper molars, a tusk, and a part of the right occipital region. This discovery is important, as it gives a wide geographical range to *M. borsonii*, which has not before been known from any pliocene bed of southern France. (Revue Scientifique, Mars, 1893.)

Dr. Noetling, in a report on Jade in Upper Burmah, says that jade is found in association with and enclosed in an eruptive rock closely resembling serpentine, and that this serpentine pierces strata of perhaps lower, but more probably Upper Miocene date. The jade found in Burmah belongs to a group of eruptive rocks of late Tertiary age. (Nat. Sci., April, 1893.)

The prevalence of lake basins in glaciated countries is accounted for by Mr. J. C. Hawkshaw by the following conditions:

Earth movements in limited areas tend to form basins; these movements are gradual, and, under ordinary circumstances, the basins are obliterated by water-borne detritus, growth of vegetation and erosion. In glaciated regions the basins are not only protected by the ice from such destructive action, but they are still further deepened by its grinding action. (Nature, April 13, 1893.)

M. M. Boule has described and figured the *Hyaena brevirostris* found by M. Aymard in the Pliocene deposits of Sainzelles near Puy (Haute Loire). Although this fossil has been referred to by Pomel, Gervais, Gaudry and Weithofer, no detailed description of it accompanied by figures has ever before been given. (Ann. Sci. Nat. Zool. t. XV, 1893.)

According to Mr. R. T. Hill, the Hematite and Martite iron ores of Mexico occur in the Cretaceous and Tertiary rocks, and are undoubtedly of later age than the rocks in which they occur. This is an unusual geologic age for ore. (Am. Journ. Sci., Feb., 1893.)

Mr. Warren gives, as a result of a comparison between pleistocene and present ice-sheets, an opinion that the Ice Age was a continuous and geologically brief period. (Bull. Geol. Soc. Am., Vol. IV, 1893.)

Mr. E. T. Dumble reports the occurrence of Grahamite in two localities in Texas. The first specimen came from the Fayette beds in Webb County, the second from the lowest strata of the Eocene exposed on the Rio Grande River in Fayette County. (Trans. Am. Inst. Mine Engineers, 1892.)

MINERALOGY AND PETROGRAPHY.[1]

The Petrography of the Abukuma Plateau, Japan.—The northern half of the Japanese Archean area, the Abukuma Plateau, is thought by Koto[2] to consist of a series of Laurentian granites and pressure gneisses, cut by younger granites and other eruptives, and overlying these a series of schists, divided by the author into lower and upper Huronian. The Laurentian granitic are an older amphibole-biotite variety and a younger, intruding biotite granite. The former contains, in addition to the usual granite components, microcline, and a bluish-green, weakly pleochroic hornblende, that very frequently plays the *role* of an ophitic groundmass for the other constituents. This granite passes by dynamo-metamorphism into foliated phases, in which the various minerals have been compressed, and the quartz, in addition, granulated. The Huronian (?) beds are principally schists and gneisses, that differ from the Laurentian gneisses in having the plane parallel structure, i. e., they are composed of bands of different composition. The most important schists of the lower division are: gneissic mica schists, containing andalusite and sillimanite, two-mica schists, one of whose constituents is margarite, garnet-biotite schist and hornblende schist. A peculiar member of the series is a titanite amphibole schist, consisting of bands whose structure is granular. Its black bands are made up of green-hornblende, plagioclase and a little biotite, and its white ones of sphene and granular sahlite in a groundmass of altered feldspar. The upper Huronian series embraces foliated amphibolites, mica-schists, and green schists that may be tufas. The distinction between the lower and upper members of the group seems to be based mainly upon petrographical characteristics. Among the rocks cutting these various schists may be mentioned an amphibole-picrite, pegmatites, and several varieties of diorite-porphyrite.

The Leucite-Tephrite of Hussak, from New Jersey.—The eleolite syenite eruption of Beemerville, N. J., was accompanied by basic extrusions now represented by the smaller dykes associated with the large eleolite-syenite dyke in this region. One of the most interesting of the basic dykes is the one at Hamburg, Sussex Co. It is from 15 to 20 feet wide and consists of a dark, tough, biotite rock, holding

[1]Edited by Dr. W. S. Bayley, Colby University, Waterville, Maine.

[2] Jour. Coll. Science, Imperial University, Japan, v, 3., p. 197.

spheroidal inclusions, that have been taken for Hussak[3] to be leucites. Kemp[4] has recently examined this rock very carefully, and now describes it as composed of biotite and pyroxene imbedded in an isotropic groundmass that is chiefly analcite. The biotite is dark brown and the pyroxene of a faint yellow color, with an extinction of 33°. The spheroidal inclusions are analcites, about whose ruins are often grouped grains of biotite and crystals of sphene. An analysis of one of the spheroids, after deducting 3.886 % of Ca Co_2, gave:

H_2O	SiO_2	Al_2O_3	Fe_2O_3	CaO	K_2O	Na_2O
6.31	52.44	26.44	.43	1.94	3.54	8.90

As to the origin of the analcite the author is not certain. It may have been derived either from leucite, in which case the rock would be a leucite-tephrite, as considered by Hussak, or it may be alteration product of nepheline.

A Sodalite-Syenite from Montana.—In the mountains forming the northern portion of Montana, Lindgren[5] and Melville have discovered post-cretaceous quartz-porphyrites, lamprophyres, augite-trachytes, analcite basalts, and a peculiar sodalite-syenite, somewhat resembling certain rocks described by Chrustschoff from Russia. The Montana syenite is from Square Butte, situated thirty miles southeast of Fort Benton. It is a light gray eruptive, associated with sheets of theralite and analcite basalt. Macroscopically it consists of lath-shaped feldspars, prisms of hornblende and pale brown grains of sodalite. In addition, analcite and plagioclase are discoverable under the microscope. Many of the feldspar crystals are corroded in an extraordinary manner and the cavities thus formed in them are filled with analcite which is believed to be an alteration product of albite. The hornblende is very dark brown, almost opaque, with a strong pleochroism, an extinction of 13° and a density of 3.437. Its analysis indicates its identity with the variety barkevikite:[6]

H_2O	SiO_2	$Al_2O_3(TiO_2)$	Fe_2O_3	FeO	NiO	MnO	CaO	MgO	Na_2O	K_2O
.24	38.41	17.65	3.75	21.75	tr	.15	10.52	2.54	2.95	1.95

The sodalite is quite fresh. It forms irregular grains that are bounded by crystal faces when in contact with analcite. It was evidently formed after the feldspar but before the analcite. The composition of

[3] AMERICAN NATURALIST., March, 1893, p. 274.

[4] Amer. Journ. Sci., Apr., 1893, p. 298.

[5] Amer. Journ. Sci., June, 1893, p. 286.

[6] AMERICAN NATURALIST, June, 1890, p. 576.

the rock as calculated from its analysis is: 23% hornblende, 50% orthoclase, 16% albite, 8% sodalite, and 3% analcite.

The Anorthosites of Canada.—The Canadian geologists have long considered the Laurentian of northern North America as consisting of an upper and a lower division, of which the latter rests unconformably upon the former. This upper division is made up largely of basic schists to which the name Novian was given by Hunt. Adams[7] has examined all of the important occurrences of the supposed schists, and has discovered that in all cases they show an irruptive contact with the surrounding gneisses, which they evidently cut. They are thus unquestionably post-Laurentian, and, from their relations to the overlying rocks, they are thought to be pre-Cambrian. The dark rocks are anorthosites—aggregates of plagioclase, with a little pyroxene, olivine and some accessories—which are in places schistose, and in other places are connected genetically with gabbros. The schistosity of the rock is accompanied by the possession of cataclastic structure, regarded by the author as due not to dynamic processes, but to the movement of the magma just before final consolidation. The plagioclase of the rock which is by far its most prominent component, is a labradorite so filled with tiny inclusions of microlites, thought by the author to be ilmenite tables, that fragments of the mineral are dark and often show the play of colors so beautifully seen in the labradorite of Labrador. The pyroxenes are a weakly pleochroic green augite, and a strongly pleochroic hypersthene. Hornblende, biotite, quartz, garnet and zircon are also present in small quantities in all specimens of the anorthosite. In the Saguenay river occurrence, olivine is enclosed in the plagioclase, and between it and the latter mineral is a reaction rim, composed of an inner zone of hypersthene, and an outer one of actinolite, including many small, green spinels. All the occurrences of the rock in Canada are briefly described, and with them are compared similar occurrences found elsewhere.

The Melibocus "Massiv" and its Dyke Rocks.—The peak of Melibocus[8] in the Odenwald consists mainly of a medium-grained white granite to the West, and a complex of schists and gneisses to the East. The granitic constituents, orthoclase and quartz, are usually aggregates of small grains variously orientated, and the biotite shows evidence of having been subjected to pressure. Near the contact with

[7] Neues Jahrb. f. Min., etc., B. B. viii, p. 419.

[8] C. Chelius: Notizbl. d. Ver. f. Erdk. z. Darmstadt, 1892, iv, F. 13 H., p. 1.

the surrounding rocks the granite becomes gneissic, and everywhere it is cut by dykes of aplites, porphyries and lamprophyres. Where the aptites penetrate the gneisses they possess the usual characteristics of these rocks, but where they pass from the schists into the granite they become porphyritic, showing a fine grained groundmass of quartz, orthoclase and mica and numerous phenocrysts of the same minerals and garnet. Like the granite the aplite components exhibit evidences of the effect of pressure. The large crystals are granulated and the rock's structure is more or less schistose. For this aplitic rock with porphyritic crystals the author, Chelius, used the name Alsbachite. An analysis of an alsbachite from the northwest side of the mountain gave:

SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	K_2O	Na_2O	H_2O
74.13	12.61	2.87	.86	.16	1.60	.23	2.13	4.55	.66

The dioritic aplites, malchite, luciite and orbite are also represented among these dyke rocks—the malchite being the panidiomorphic diorite aplite, the luciite the hypidiomorphic granular forms, and the orbite the corresponding porphyritic phases. One of the luciites is described as made up almost exclusively of plagioclase and hornblende. Among the lamprophyric dykes, mention is made of a gabbrophyre, or odinite, which differs from the gabbro-aplite, beerbachite, in consisting of phenocrysts of plagioclase and colorless augite in a matrix of plagioclase laths and hornblende needles, while the aplite is a panidiomorphic aggregate of diallage and feldspar, with the addition, sometimes, of hornblende crystals that enclose the other constituents. The descriptions of all these rare rocks are very brief.

The Granites of Argentina, S. A.—In an elaborate description of 185 hand specimens of stock and dyke granites and pegmatites, cutting the archean and paleozoic beds of Argentina, and of younger granites cutting these older ones, Romberg[9] discusses at some length the origin of the micropegmatitic intergrowth of quartz and feldspar. He believes that in the rocks studied by him the quartz in the intergrowths is secondary, and that it has originated in the decomposition of orthoclase and plagioclase. Many micro-photographs accompanying the author's article illustrate clearly the steps by which this conclusion was reached. Although the description of the specimens is exhaustive, it contains no points of special interest. At the conclusion of the paper is a list of the specimens examined, with their localities,

[9] Neues Jahrb. J. Min., etc. B. B. viii, p. 275.

and appended to it are twelve plates containing seventy-two micro-photographic reproductions of their sections.

New Minerals.—*Geikielite.*[10]—This mineral was found as pebbles in the gem washings near Rakwana, Ceylon. It is essentially a magnesium titanate, $MgTiO_3$, corresponding to the calcium compound, perofskite. The mineral is bluish-black and opaque, with a brilliant lustre, and possessing two cleavages at right angles to each other. Its density is 3.98 and hardness 6.5. In thin section it is translucent with a purplish-red tint, and in converged light it shows a uniaxial figure.

Baddeleyite,[10] also occurring as pebbles in the above-mentioned locality, is a black substance with a density of 6.02 and a hardness of 6.5, thus strongly resembling columbite. Under the microscope small fragments are seen to be dichroic in greenish-yellow and brown tints, and to possess a biaxial symmetry. The crystallization is thought to be monoclinic, though only a few plans could be detected on the specimen. In chemical composition the substance is zirconia ZrO_2.

Folgerite, blueite and *whartonite* are all nickel-iron-sulphides from the Sudbury nickel mines at Algoma, Ontario. Emmens[11] describes the first named as a massive, bronze-yellow substance, with a grayish-black streak, a density of 4.73 and hardness 3.5. Its composition (Fe $= 33.70$; Ni $= 35.20$; S $= 31.10$) corresponds to $Ni\,Fe\,S_2$.

The *blueite* is also massive. Its color 'is olive-gray or bronze; its streak black, density 4.2 and hardness 3–3.5. Its analysis yielded Fe $= 41.01$; Ni $= 3.70$; S $= 55.29$, corresponding to pyrite with a thirteenth of the Fe replaced by Ni. Unlike pyrite, however, it dissolves easily in nitric acid, without the precipitation of sulphur.

Whartonite differs from blueite in containing more Ni. Its composition is Fe $= 41.44$; Ni $= 6.27$; S $= 52.29$, corresponding to $(Fe\,Ni)\,S_2$ in which Fe : Ni $= 7:1$. Its hardness is 4, density 3.73, and color and streak like those of blueite.

Hauchecornite is another nickel mineral. It is described by Scheibe[12] from the Friederich mine in the Hamm mining district, Germany. It is found in bronze-yellow tetragonal crystals, with a hardness of 5, and a density of 6.4. It is thought to have the composition corresponding to the formula Ni (Bi. Sb. S), though analysis yields discordant results.

Cuprocassiterite was described by Ulke[13] from the Etta mine, South

[10] Fletcher: Nature, Oct. 27, 1892, p. 620.

[11] Jour. Amer. Chem. Soc., Vol. xiv, No. 7.

[12] Jahrb. A. preuss. geol. Landeranst, 1891, p. 91.

[13] Proc. Amer. Inst. Min. Engineers, Feb. 1892.

Dakota, but the author's data were so scanty that Headdon[14] has thought it advisable to add a small additional contribution to the literature of the mineral. This last-named writer obtained a small quantity of what he supposed to be Ulke's new mineral from both the Etta and Peerless mines, and found upon examination that in the interior of a small mass from the Peerless mine is a nucleus of stannite containing a little cadmium. Intergrown with this and also forming an envelope around it is a green clayey substance, which, upon its exterior, passes into a yellow earth. The green substance has a density of 3.312–3.374. Its analysis shows it to be a mixture of about 7 SnO_2, 6 CuO, 2 FeO and 11 H_2O. The author regards it is an alteration product of stannite, but not as a well-defined mineral species.

New Edition of Rosenbusch's Volume on Minerals.—The new edition of Professor Rosenbusch's[15] Microscopic Physiography of the Rock-forming Minerals is an enlargement rather than a revision of the second edition. There is no material difference in the arrangement of the matter in the two editions, but there have been large additions made in the later volume in the shape of descriptions of new petrographical apparatus and methods, and in the number of minerals treated. The plates illustrating the text have been decreased by one. The remainder are much better executed than was the case in the earlier volume.

Mineral Syntheses.—Michel[16] has obtained *melanite* garnets and *sphene* crystals by cooling slowly a mixture of 10 parts titanic iron, 10 parts calcium sulphide, 8 parts silica and 2 parts carbon, that had been heated to 1200° for five hours.

Crystallized *leucite, potassium cryolite* and *potassium nepheline* results from the fusion of silica or of fluosilicate of potassium and alumina with an excess of fluoride of potassium. Prolonged heating produces leucite, and potassium cryolite. Less prolonged treatment yields a potassium nepheline, which crystallizes in negative orthorhombic prisms.[17].

Instruments.—For measuring the curves of isotherms on mineral plates Jannetaz[18] has constructed a new ellipsometer, which it is

[14] Amer. Jour. Sci., Feb., 1893, p. 105.

[15] H. Rosenbusch: Mikroskopische Physiographie der petrographisch wichtigen Mineralien, Stuttgart, 1892, pp. 712, Fig. 239, etc.

[16] Comptes Rendus, Vol. cxv, p. 830.

[17] Duboin, Bull. Soc. Franc. d. Minn., Vol. xv, p. 191.

[18] Bull. Soc. Franc. d. Minn., Vol. xv, p. 237.

believed will enable its user to measure accurately the axes of the isothermal ellipses, and to determine rapidly in each case whether apparently circular isotherms are in reality circles or slightly eccentric ellipses.

A new machine for cutting and grinding thin sections of rocks and minerals, with stored electricity as the motive power, is described by G. H. Williams[19].

Rock Separations.—Thallium-silver-nitrate [$Tl\ Ag\ (NO_3)_2$], according to Retgers,[20] is an excellent medium for the separation of mineral grains of great density. The double salt fuses at 75°, and in the fused condition is clear and mobile. In this condition its specific gravity is 5, and this may easily be lowered by the addition of water. Its manipulation is simple. A small beaker containing the solid salt is placed in a water bath and heated. Upon its liquefaction the powder to be separated is added and the mixture is allowed to stand for a short time. As soon as a layer of clear liquid forms between the precipitated and the floating grains the beaker is plunged into cold water. The salt thus consolidates rapidly. The beaker is now broken and the heavy grains are collected by scraping and washing.

A new method of separating the constituents of rock powders, whose densities are above 2.60, has been devised by Dafert and Derby.[21] The principle involved is the suspension of small particles in gentle currents of water. The apparatus necessary for the operation is fully described by the authors. Separation is not complete between powders of nearly the same density, but there is a strong concentration of the heavier and the lighter ingredients in the two resulting portions of the separated material.

[19] Amer. Jour. Sci., Feb. 1893, p. 102.

[20] Neues Jahrb. f. Min., etc., 1893, Vol. I, p. 90.

[21] Proc. Roch. Acad. Sci., Vol. II, p. 122.

BOTANY.

Cæoma nitens.—The development of *Cæoma nitens* has recently been studied by Mr. H. M. Richards, and the results published in an interesting paper in the Proceedings of the American Academy of Arts and Sciences. The particular question investigated was whether or not the spermogonia are developed within the cavities of the epidermal cells of the host. By means of carefully made sections, Mr. Richards demonstrates that they arise as masses of hyphæ which push up *between* the epidermal cells, and that later the walls of some of these cells become absorbed. The spermogonia are therefore at first intercellular, but by the absorption of the walls they become intracellular.

CHARLES E. BESSEY.

Our Naiads.—Thomas Morong's monograph "The Naiadaceæ of North America" has been brought out in the *Memoirs of the Torrey Botanical Club.* It contains descriptions and plates of 54 species distributed as follows: *Triglochin*, 3 species; *Scheuchzeria*, 1; *Lilæa*, 1; *Potamogeton*, 37; *Ruppia*, 2; *Zannichellia*, 1; *Naias*, 4; *Zostera*, 3; *Phyllospadix*, 2. Among these we find one new species *Potamogeton faxoni* from Lake Champlain, and several new varieties of previously described species. Quite a number of changes have been made in the nomenclature of the species.

Thus comparing Dr. Morong's list with that in the 6th edition of Gray's "Manual," we note the following changes: *Potamogeton pennsylvanicus* Cham. and Sch. becomes *P. nuttallii* Cham. and Sch., since the latter was described on an earlier page of *Linnæa* than the former (II. 1827); *P. hybridus* Mx. (1803) being preoccupied (by Thuillier in 1790), gives way to *P. diversifolius* Raf. (1808); *P. rufescens* Schrad. (1815) is antedated by *P. alpinus* Balbis (1804); *P. fluitans* Roth. (1788), gives way to *P. lonchites* Tuck. (1848), inasmuch as it is highly improbable that the European and American species are identical; *P. zizii* Mert. and Koch. of the "Manual" appears to have included two species which are now to be known as *P. spathulæformis* (Robbins) Morong, (*P. gramineus*, var. (?) *spathulæformis* Robbins, *P. spathæformis* Tuck., and *P. varians* Morong), and *P. angustifolius* Berch. and Presl. (*P. lucens*, var. *minor* Nolte); the var. *lanceolatus* Robbins (1867) of *P. perfoliatus* L. being preoccupied by Blytt (1861) must give way to var. *richardsonii* Ar. Bennett (1889); *P. pauciflorus* Pursh. (1814) must be replaced by *P. foliosus* Raf. (1808); *P. mucron-*

atus Schrader, being uncertain, the species is to bear the name of *P. major* (Fries) Morong; *P. tuckermani* Robbins (1856) gives way to the earlier *P. confervoides* Reichb.; *P. marinus* L. turns out not to be that species, and must take the name *P. filiformis* Pers. (1805).

CHARLES E. BESSEY.

Hough's American Woods.—The third part of R. B. Hough's "American Woods" has recently been distributed. The twenty-five species in this part are *Magnolia glauca, Ilex opaca, Acer rubrum, A. negundo, Prunus pennsylvanica, P. avium, Pyrus communis, Cratægus punctata, Amelanchier canadensis, Liquidamber, styraciflua, Diospyros virginiana, Fraxinus sambucifolia, Morus rubra, Hicoria sulcata* (*Carya sulcata*), *H. glabra* (*Carya porcina*), *Quercus bicolor, Q. prinus, Q. muhlenbergii, Q. coccinea, Betula populifolia, Salix amygdaloides, Populus tremuloides, P. dilatata, Chamæcyparis thyoides, Pinus mitis.*

Each species is represented by three sections of the wood, transverse, radial and tangential, each 4½ by 2 inches. A good descriptive text accompanies the set of specimens. The parts are sold by the author at Lowville, N. Y., for the low price of five dollars each.

CHARLES E. BESSEY.

Allen's Characeæ of America.—Five years ago Dr. T. F. Allen of New York City brought out Part I of a promising work on the Characeæ of America, consisting of an introductory chapter on the structure, followed by the keys to the species of all our genera. He has now brought out the first fascicle of Part II in which he begins the work of carefully describing and illustrating every species. The illustrations are ample, there being no less than fourteen plates for the eight species of *Nitella* included. The descriptions are full and apparently well drawn up, measurements being fully given. The following are the species described:

N. opaca Ag.—New England and Canada to California and Mexico.

N. obtusa Allen.—A new species from Lake Tamiscouata, Canada.

N. montana Allen.—A new species from Montana.

N. blankinshipii Allen.—A new species from Missouri.

N. missouriensis Allen.—A new species from Missouri.

N. flexilis Ag.—Across the continent.

N. subglomerata A. Br.—N. Y. and N. J. to Oregon, Texas and Missouri and the var. *brachyteles* A. Br. of this species occurs in Mexico Alabama.

N. glomerulifera A. Br.—Mass. to N. J., Ohio and Louisiana.

Every botanist will hope for the early appearance of the succeeding fascicles.

CHARLES E. BESSEY.

ZOOLOGY.

A Medusa from Lake Tanganyika.—In the "Annals of Natural History," for the present month, will be found an account of a very interesting zoological novelty. Mr. R. T. Günther describes and figures a remarkable new form of Medusa, or jelly-fish, that occurs in Lake Tanganyika. Until recent years, when the little Limnocodium was found living in the Victoria lily-tank of the Botanic Gardens, Regents Park, it was believed that the Medusæ were nearly exclusively oceanic. It is now shown that the freshwater lake Tanganyika is the home of a peculiar member of this group. The existence of such an organism in Tanganyika was asserted some years ago by the German naturalist, Dr. Boehm, and Professor v. Martens, of Berlin, even went so far as to name it Tanganjicæ, although he had never seen a specimen. Mr. Günther now supplies us with a full description of this singular Hydrozoon, which he refers to a new genus, Limnocnida, adopting the suggestion of v. Martens as to its specific name. *Limnocnida tanganjicæ* is, as might have been anticipated, perfectly different from all the members of the group hitherto known, and probably represents a distinct family, but its exact position cannot be settled positively until the mode of its development has been ascertained. (Nature, April 13, 1893.)

The Air-Bladder and Weberian Ossicles in the Siluroid Fishes.—A study of the physiology of the Weberian ossicles and of the air-bladder in general has been made by Professors T. W. Bridge and A. C. Haddon, for the purpose of discovering the physiological relation of the Weberian mechanism to one of the several functions that have been ascribed to the auditory organ or to the air-bladder. With this object in view they discuss (I) how far the function of the Weberian mechanism is conditioned by the anatomical structure of the air-bladder and auditory organs as well as by the character of the mechanism itself; (II) to which of the known functions of the air-bladder and auditory organ the Weberian ossicles are to be regarded as accessory structures; and (III) the utility of the mechanism to the fish possessing it.

The authors find (I) that from the anatomical structure of the parts the Weberian apparatus is better adapted to register the more forcible distentions or contractions of the anterior chamber of the air-bladder

rather than the slight or rapidly recurring vibrations of its lateral walls. (II) The ossicles under consideration are accessory to the hydrostatic function of the air-bladder. (III) The Weberian mechanism is of great functional importance to the fish possessing it, since it confers on them an exceptional capacity for freedom of locomotion in a vertical direction. The possession of this mechanism permits all movements to be made with the maximum economy of muscular effort and tissue metabolism.

In regard to the evolution of the Weberian mechanism the authors reach the following tentative conclusions:

1. The special feature of a fresh-water habitat that has conditioned the development of the Weberian mechanism in the Ostariophyseæ is the occurrence of seasonal or periodic quantitative variations in the food supply, variations to which the Ostariophyseæ, from their herbivorous or omnivorous habits are specially liable. ;

2. In view of such unfavorable nutritive conditions, the special advantage which is conferred upon the Ostariophyseæ by the possession of the Weberian mechanism is a capacity for executing locomotor movements in any plane, with an almost irreducible minimum of muscular effort and tissue metabolism.

3. If a variable and inconstant food supply is to be regarded as one of the inevitable conditions of a fresh-water existence, and necessitates strict economy in the expenditure of muscular energy, any mechanism which secures this result must be of unquestionable importance to the species, and hence it may be that the Ostariophyseæ owe their dominant position among fresh-water fishes to the possession of the Weberian mechanism.

4. The evolution of the Weberian mechanism has not only conditioned the predominancy of the Ostariophyseæ, but, indirectly, has favored the existence in fresh water of a large number of purely carnivorous fishes, which depend on the former for their food, and therefore may also be regarded as one of the primary causes of the anomalous abundance and diversity of fresh-water piscine life, as compared with the remarkable poverty of all other groups of fresh-water organisms. (Proceeds. Roy. Soc. Vol. LII, 1892).

Age Modifications of the Mucous Lining of the Stomach of Ruminants.—In a study of the Comparative Anatomy of the Stomachs of Ruminants, Mr. J. A. Cordier has discovered the following interesting facts.

The interior of the stomach of a young adult is covered with papillæ closely packed, which are larger in the region which Wilkins calls the

"col" of the paunch, than on the rest of the surface. In the stomach of a very old animal a different condition exists. The large papillæ of the "col" are few and far between—two or three times as far apart as in the younger animal, much smaller, twisted once on the base, evidently becoming atrophied. Between these papillæ can be seen traces of many others which have disappeared, leaving their bases only as vestiges, and these are entirely covered by the ordinary epithelium of the stomach.

That these papillæ do not renew themselves is shown by histological sections of the papillæ. In a bison, thirty years of age, the papillæ were almost entirely wanting. An antelope and a ram showed the process of degeneration very clearly.

The second age modification is the appearance of a black coloration more or less intense over the entire surface of the stomach. Observations so far, however, show that this modification takes place in domestic animals only. [Bull. Soc. Zool., T. XVII, 1892.]

Zoological News.—According to C. H. Eigenmann, the development of the Point Loma blind fish (*Typhlogobius californiensis* Steindachner), is a striking example of the degeneration of the eyes. The embryo, before it is hatched, has eyes developed as well as the embryo of any other fish. When the individuals have reached the length of an inch they can still see a short distance, but it is evident that the eye has stopped growing long before this age is reached. In the adult condition the eye has become degenerated and covered with a thick skin, and the fish is totally blind. (Proc. U. S. Natl. Mus., 1892.)

In his Comparative Notes on Swifts and Humming-Birds, Dr. Shufeldt submits 61 important structural differences existing between the *Cypseli* and the *Trochili.* These differences, in the author's opinion, establishes the fact that these two groups, morphologically speaking, are not related. (The Ibis, Jan., 1893).

A new rat, *Perognathus merriamii,* is described by J. A. Allen, from southeastern Texas. It is allied to *P. flavus,* but differs from it in coloration, in the general form of the skull, and in the relative size and proportions of special parts of the skull. The species is based on 17 specimens from Brownsville, Texas. (Bull. Am. Mus. Nat. Hist., 1892.)

Mr. Amos Butler reports that the "Least Shrew," *Blarina parva* (Say), the smallest mammal in the United States, is rather common in the Whitewater Valley in Indiana. (Proc. Indiana Acad. Science, 1891, p. 163, 1893.)

Mr. Witmer Stone notes the occurrence of the genus Neotoma in Pennsylvania. The specimens, which were secured near the top of South Mountain in Cumberland Co., evidently belong to a new species, and are described by Mr. Stone under the name *Neotoma pennsylvanica.* This species is distinguished from *N. floridana* by its larger size, its densely hairy and distinctly bicolored tail, and by certain well-marked cranial characters. (Proceeds. Phila. Acad., 1893.)

ENTOMOLOGY.[1]

North American Cosmetidæ—A recent study of a considerable collection of Cosmetidæ from the Southern States shows that three well-marked species occur in our fauna. This family belongs to the sub-order Mecostethi of Simon or Laniatores of Thorell, of the order Opileonea. Say described one species, Wood another and Sorensen the third. The three species are closely related and all belong to the genus Cynorta. They may be separated by the following key:

Posterior pair of abdominal tubercles very prominent; four or five times as large as anterior pair. . . . . . *C. ornata.*

Posterior pair of abdominal tubercles little larger than anterior pair.

Dorsum with a distinct yellow Y connected posteriorly with a transverse yellow line. *C. albolineata.*

Dorsum without or with very little yellow marking. *C. sayi.*

Cynorta ornata is abundant in Florida and probably occurs in the South Atlantic States; *C. albolineata* is found in Louisiana and Mississippi; and *C. sayi* in Texas. An illustrated descriptive synopsis of these species is now in the hands of the American Entomological Society for publication in the *Transactions.*—CLARENCE M. WEED.

An American species of Sabacon.—In 1879, the French Arachnologist, M. Eugene Simon established[2] the genus Sabacon for a very peculiar species (*S. paradoxus*) of the family Ischryopsalidæ—one of the smaller families of the Opileonea. The specimen described was immature and the lateral pores were not distinct. No other species of the genus appear to have since been described.

The genus Sabacon is especially characterized by the peculiar form of the palpi, the joints of which are large and swollen, and the short

[1]Edited by Prof. C. M. Weed, New Hampshire College, Hanover, N. H.

[2]Arachnides de France, VII, 266.

tarsus is not provided with a claw, but is capable of being turned back against a depression in the tibia. The mandibles are shorter than the body.

During the autumn of 1892, I found under a piece of driftwood along a small creek, a fully developed male belonging to this genus. The species is evidently rare for I have never been able to find another although I have searched persistently.

Sabacon spinosus, n. sp.

Male.—Body 3 mm. long, 2 mm. wide; palpi, 3 mm. long. Legs: first, 11.5 mm.; second, 19 mm.; third, 12 mm.; fourth, 16.5 mm.—Body testaceous with dusky markings; the markings on dorsum arranged transversely and following segmentation. Palpi and legs light testaceous with almost continuous dusky blotches. Ocular tubercle black, very near front margin of cephalothorax, much wider than long, low, with a deep longitudinal sinus but no spines on carinæ. A small round, not very distinct pore on each cephalo-lateral angle of the dorsum, not isolated by distinct oblique sinuses. On the dorsum of the cephalothorax and the ocular tubercle are many short, acute, black spines arranged more or less irregularly; back of ocular tubercle on cephalothorax are two transverse rows of similar spines, and on

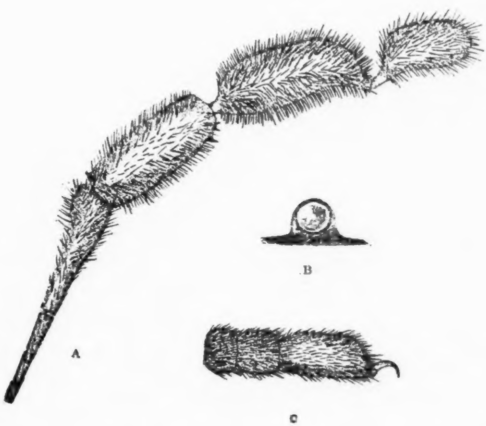

Fig. 1.—*Sabacon spinosus.* Male: *A*, palpus; *B*, eye eminence; *C*, distal tarsi of first leg. All magnified.

abdomen are many more similar rows. The ventrum of abdomen is also provided with such rows, and the ventrum of the cephalothorax including coxæ is covered with these spines. Palpi large and longer than the body; thickly covered with long black spines; femur enlarging a little from base to apex; patella thick, subcylindrical, with a conical tubercle on ventral surface near distal end; tibia slightly petiolated, curved and attenuated distally, hollowed out on under side to receive tarsus; tarsus petiolated, swollen, a little more than half as long as tibia, rounded at end and having no claw; capable of being turned back upon the tibia like a thumb. Mandibles short, much shorter than body; first joint having a large, truncate, wart-like tubercle on dorsal surface near distal end; top of tubercle and dorsal surface of distal portion of the joint thickly furnished with stiff spinose hairs; second joint short and thick, provided dorsally with similar hairs; claws curved, unequal. Legs rather slender, with rows of spinose hairs on proximal joints. Shaft of genital organ long, flattened; toward tip enlarging into a spoon-shaped portion, from which there projects forward a long slender piece gradually coming to very acute point.

Described from one specimen taken at Hanover, New Hampshire.

CLARENCE M. WEED.

The Puparium of Jurinia.—In a paper recently sent to the AMERICAN NATURALIST, I described the puparium of *Blepharipeza*. The present paper describes the puparium of *Jurinia*, which genus, while it belongs to the same group as *Blepharipeza* (Hystriciinæ), shows considerable difference in the puparium. The description is drawn from a puparium of *Jurinia algens* Wd., from which issued a ♀ specimen of the fly, bred by Professor C. P. Gillette from *Hadena lignicolor*, in Colorado.

Puparium of *Jurinia algens* Wd.—Length, 12 mm.; greatest width (8th segment), 5½ mm. Color reddish brown, capital tubercles and anal stigmata blackish. Puparium consisting of 12 segments, including capital and anal plates, more or less cylindrical, bulging a little posteriorly, the anterior end being less in diameter than the posterior end, while the eighth segment is the widest portion. The rugose belts described in *Blepharipeza* are absent, the whole surface being more or less fluted, the flutings showing most plainly on the three anterior segments next the capital plate, becoming less distinct in the middle or giving way to an almost smooth surface, and reappearing in irregular flutings, or minute furrows and ridges, on the last three segments and

anal plate. The larval mouth parts are represented on a portion of the capital plate forming part of the single anterior flap which is present, by two small erect tubercles projecting straight out from the surface of the integument, situated at edge of capital plate, and on opposing sides. The remaining portion of the capital plate, which is absent, the other flap being detached and missing, doubtless bears a third similar erect tubercle, the three being so arranged that they represent the corners of a nearly equilateral triangle. These tubercles are erect, about as high as their basal diameter, ending in a blunt but laterally compressed apex, the apical diameter one way equalling the basal while the other way it is much less than the basal, the apical surface with about 4 faint transverse notches leaving 5 faint transverse ridges. The longitudinal axis of the compressed apex of each tubercle is at an angle of about 45 degrees with the margin of the capital plate. The surface of the capital plate is more or less irregularly transversely, not circularly, fluted. Anal stigmata situated in center of anal plate, consisting of two erect raised organs, not as far apart as the diameter of either, each consisting of 3 ridge-like sections separated by deep notches, the flap-like ridges of each stigma quite closely approximated at their inner ends and widely divergent outwardly, the superior and inferior ones diverging at nearly a right angle. Each of these keel-like ridges bears a longitudinal median suture or fissure its whole length. These stigmatic organs, unlike those of *Blepharipeza* and many other tachinids, project straight out from the surface of the integument, being about as high as their diameter. A little distance ventrally (? dorsally) of the pair of anal stigmata, being situated on anterior border of 10th segment, is a small slit-like opening in the integument resembling a spiracle, its longer diameter being longitudinal to the puparium. The vent-like anal tubercle described in *Blepharipeza* is not present.

Supplementary note to description of puparium of *Blepharipeza.*—In the description above referred to, of the puparium of *Blepharipeza adusta* Lw., I mentioned only one tubercle on the capital plate. This was all that was present on the nearly detached anterior flap of the puparium, the correspondihg flap on the opposite side being missing. It should have been mentioned that the absent portion of the capital plate doubtless bore two more tubercles similar to the one described, situated near the edges of the plate as was also the latter, the three being arranged in a triangle, but not so far apart as in *Jurinia*, being of larger size.—C. H. TYLER TOWNSEND.

Notes.—In Bulletin No. 19 of the Iowa Experiment Station, Prof. Herbert Osborn reports further experiments in destroying leaf-hoppers; Mr. H. A. Gossard discusses the Clover-seed Caterpillar (*Grapholitha interstinctana*); and Mr. F. A. Sirrine treats of the Potato-stalk-weevil (*Trichobaris trinotata*). The latter species has been found breeding in "ground cherries" (*Physalis*).

Prof. S. W. Williston contributes to the third number of the Kansas University Quarterly the third part of his Diptera Brasiliana, and an illustrated paper on the Apioceridæ and their allies.

Mr. F. M. Webster publishes[3] extended accounts of the insects affecting the blackberry and raspberry, and the underground insect destroyers of wheat. The former article enumerates 88 species.

Mr. M. V. Slingerland[4] calls attention to the fact that the black peach aphis (*Aphis persicæ-niger*) is being introduced into New York through peach trees purchased in Delaware. The author describes the indications of the presence of the pest; its past history; its classification, appearance, and life history and remedial measures.

Professor J. B. Smith presents[5] an interesting illustrated discussion of the grasshoppers, locusts and crickets affecting cranberries. He shows that contrary to the usual belief it is the katydids and not the common grasshoppers that attack this fruit.

A catalogue of the South American species of Calyptrate Muscidæ by Prof. C. H. Tyler Townsend has lately appeared in the Annals of the New York Academy of Sciences. (Vol. VII, Dec., 1892).

[3]Ohio Agr. Expt. Station, Bulletins 45 and 46.

[4]Cornell Univers. Agr. Exp. Station, Bull. 49, p. 325.

[5]New Jersey Agr. Exp. Station, Bull. 98.

ARCHEOLOGY AND ETHNOLOGY.[1]

The International Congress of Americanists.—(Continued from page 305)—FIFTH CONGRESS AT COPENHAGEN, 1883.—The folpapers were read and addresses made:

Observations upon some of the skulls and human bones of the Minasgeraes in Brazil, by M. Lutken; Note on the Quaternary Fossil Animals, Fauna of the Plateaux of the Andes; An Examination of the Discovery of the American Continent by Christopher Columbus, and the assistance given to him by Martin Alonzo Pinzon, by M. Herrera; Aboriginal American Literature, by Dr. Brinton; The Vineland Excursions of the Ancient Scandinavians, by M. Loffler; The Pre-Columbian Relations of the Gaels with Mexico, by M. Beauvois; Old Scandinavian Ruins in the District of Julianehaab, South Greenland, by M. K. Steenstrup, with two plates; Three Ancient Charts of the North, by Baron Nordenskiöld, explained by M. Christian Bahnson; M. Lucien Adam, upon the theory announced by M. Hale, relative to the Origin of America; M. Bamps, On the Traditions Relative to the White Man and the Sign of the Cross in America, prior to the Discovery; and a Criticism upon the Theory of Abbe Schmidt, which had been announced in the former Congress; The Lost History of America, by Mr. Steven Blackett; To what Point did the Ancient Scandinavians Penetrate near the North Pole in their Expeditions over the Glacial Sea? by M. Brynjulfson; The Voyages of the Brothers Zeni in the North, by M. J. Steenstrup; Nautical Remarks about the Zeni Voyages, by M. Irminger; Cartography of the American Continent, by M. Anatole Bamps; The Voyages of the Danes in Greenland, by M. Valdemar Schmidt; Peruvian Vases in the Archæologic Museum of Madrid, by M. de la Rada; Polynesian Antiquities, a Link Between the Ancient Civilizations of Asia and America, by Mr. Francis A. Allen; American Pottery in Pate and Fabrication, by Anatole Bamps; On the Paleolithic Implements of the Valley of the Delaware near Trenton, by Dr. C. C. Abbott; Ancient Ornaments of Pottery, by E. Barber; Memoir on the Shell Mounds of the Chesapeake Bay and Potomac and Wycomico Rivers, by Elmer T. Reynolds; Prehistoric Archæology, by Baron Joseph de Baye; The Art of Ornamentation Among the American People, by M. Stolpe; The Dialect of the Eskimo Language, with a synoptical table of words arranged after the system of the Greenland

[1]This department is edited by Dr. Thomas Wilson, of the U. S. National Museum.

Dictionary by M. Rink. The author divides the Eskimos into six groups: the Greenlander, the Labradorian, the Eskimos of Makenzie, the Eskimos of the West, and the Aleutes—Wherein does the Eskimo Language Differ Grammatically from the other Languages of North America, by M. Lucien Adam; M. Leon de Rosny had made a Volume on the Deciphering of the Maya Inscriptions, the which M. Rada Translated and Presented to the Congress with an Analysis and Criticism; The Language Timucua, by M. Vinson; M. Vahl presented an ethnographic chart of North America for the Danish Missionary Society, which he explained; The Coloring Matter Employed by the American Indian, by M. Vera; The Variations in the Physical Geography of the American Continent, from the discovery to the present—M. Vera; and the Formation of the Words of the Maya Language, by the Count de Charencey.

The Fourth and Sixth Sessions were held respectively at Madrid, and Turin. I have no report of these Congresses.

The Seventh Session was held at Berlin from the 2d to the 5th of October, 1888. The papers read and addresses delivered were substantially as follows:

The Basques, Britons and Normans on the Coast of North America during the early part of the XVI Century, by M. Gaffarel, 9 pages; Publication of the Writings and Documents Relative to Christopher Columbus and his Time on the Occasion of the Celebration of the Fourth Centenary of the Discovery of America, by M. Cora; An Historical Essay on the Primitive Legislation of the Spanish State of America, by M. Fabie; On the Nahuatl Version of Sahagun's Historia de la Nueva Espana, by Dr. Brinton, with its discussion, 6 pages; On Certain Archæologic Objects of Mexico and South America, by M. Heger, 5 pages; The Stone Colliers of Porto Rico, by Jimenez de la Espada; Antiquities of Vera Cruz; Archæologic Results of the Later Voyages in Mexico, by M. Seler; An Ancient Mexican Mosaic, by M. Andree; Notes on the Origin, Working Hypothesis and Primary Researches of the Hemenway Southwestern Archælogical Exposition, by Mr. F. H. Cushing; The Antiquities of Nicaragua, by M. Bovallius; The Ceramic Antiquities of the Isle of Marajo, and also on Nephrite and Jadeite, by M. Netto; Place of Origin of Nephrite and Jadeite, by M. Virchow; The Aztecs and their Probable Relation to the Pueblo Indians of New Mexico, by Mr. S. B. Evans; The Employ of Cocoa in the Northern Part of South America; American Craniology, by Virchow; An Anatomical Characteristic of the Hyoid Bone of Pre-Columbian Pueblo Indians of Arizona, by Drs. Wortmann and Ten

Kate; The Chronology of Dilluvial Man in North America, Emile Schmidt; Indication of the Vestiges of the Pre-Columbian Population of Nicaragua, M. Desiré Pector; Human Sacrifice in America During Pre-Columbian Times, by M. Grossi; Cremation in America Before and After Christopher Columbus, by M. Grossi; Anthropology of the People d'Anahuac in the Times of Cortez, by M. Hartmann; Was America Peopled from Polynesia? by Horatio Hale; Study of the Mam Language, by the Comte de Charency; Vocabulary of the Language Timucua, by M. Raoule de la Grasserie; The Linguistic Family of Pano, by the same; The Historic Archives of the Hemenway Southwestern Archæological Expedition, by M. Bandelier; On the Sambaquis of Brazil, by M. H. Muller; Ancient Map of America, by Gaffarel; Three Linguistic Families in the Amazon and Orinoco Rivers, by M. Adam; Bibliography of Recent Linguistic Investigations in South America, by the same; Maya Handwriting by M. Förstemann; A Chronologic Classification of the Architectural Monuments of Ancient Peru, by M. Borsari; Contribution to Americanism of Cauca (United States of Columbia) by M. Douay; The Language of the People of the Center of South America by M. Von Den Steinen; Peruvian Figures in Silver, by M. Luders.

Language vs. Anatomy in Determining Human Races.—"Anthropologie," replying to criticisms of Dr. Sergi's work, thus states the position of French Anthropologists on this controverted subject:

The Anthropologists of France are unanimous that some or a few (anatomic) characters are not sufficient to determine a type of race; but there should be an investigation of all or as many as possible, and Anthropology does not interfere with Ethnography. They are occupied with different things. Anthropology does not say that physical characters are superior or inferior to linguistic characters; it says the two sciences are of a different order and for a different purpose. The first relates to the physical element constituting peoples; the second to the classification of these peoples. Language grows, loses, borrows, changes, transforms, and all this independent of the Anthropological characters, such as beliefs, customs, industries. Physical characters are hereditary and inherent in the blood, while linguistic characters are not. A red Indian, born among strangers and without the society of his parents or race, will speak, not his own language, but the language of those who rear him, and, nevertheless, retain all the physical characters of his race. Different and opposing races may speak the same language, and per contra, the same race may speak different languages.

Much of the contest which has developed in the United States as to the relative value of language arises from the confusion of the terms Anthropology, Ethnology, Ethnography. The French writer makes a distinction easily understood and maintained, and quite harmonious with the "Nomenclature of Anthropology" as presented by Dr. Brinton and commented on by Major Powell before the Anthropological Society of Washington (Amer. Anthrop., July, 1892, Vol. V, No. 3, p. 265, et seq).

Language may be of great value, and should never be neglected in determining living or historic races. In determining prehistoric races, it cannot be studied because in most cases it is unknown, and so we are driven to consider the physical characters. Because language assists in determining historic races, it does not follow that in the prehistoric races no other means can be used.

The true rule seems to require the employment of all possible means, and even then the decision may not be either harmonious or correct.

The Nephrite of New Zealand.—MM. Duparc and Morazec have published in the Archives of Natural and Physical Science, Geneva, a paper on Nephrite of New Zealand. Speaking of the number of hatchets and other objects from the Swiss Lakes in the museums which have passed as Nephrite, they express doubt and counsel circumspection. They do right and are to be approved. But when they say that they have found but one piece which from its appearance could be identified as nephrite, their proposition is doubtful. There are many polished specimens of the hard, greenish stone in the Swiss Museums, which stand tests of hardness and density required for Nephrite, and which have been called so. If not Nephrite, they are still some varieties of Jade. One or more of their components may be soda or aluminum instead of lime or magnesia; and they may be Jadeite, fibrolite, saussaurite or another variety of Jade.

While many of these polished objects can be determined with reasonable certainty on inspection and from appearance, yet there are many which possibly cannot be. That is to say, they correspond in appearance, and they stand the tests of hardness and density, and may be either the one or the other, depending upon their chemical combination, and this similarity may be so great that it is doubtful if, in disputed cases, anyone can determine without analysis or microscopic examination of thin sections. If MM. Dupare and Morazec examined the doubtful or contested specimens of the Swiss Museums in this way, their determination would be accepted, but if from mere external

appearance, the subject is still open. Their conclusions may be quite correct, but examination from external appearance does not prove it. One great trouble arising in the discussion of this subject is that the destruction of the object consequent upon analysis and thin section prevents a satisfactory and competent determination.

MICROSCOPY.[1]

A Method for Injecting the Blood-Vessels in Birds.— I presume all who give a laboratory course in Comparative Anatomy have, in common with myself, experienced difficulty in injecting the arterial and venous systems of birds. The usual directions are to inject the arterial system through the pectoral artery, and the venous system either through the pectoral vein or through the coccygeo-mesenteric vein. The blood of birds coagulates very rapidly, and even when the procedure is carried out as expeditiously as possible, failure frequently occurs from the inability of the operator to remove the greater part of the blood from the animal, or from vexatious delays in tying a canula in the divided vessel. For some time I have been using the following method, and have not failed in securing the most satisfactory results. It possesses the additional advantage of being quickly performed.

The bird, a pigeon for example, is placed under a bell-jar and chloroformed in the usual way. While the bird is getting under the influence of the anesthetic, the operator should see that there is, within convenient reach, a scalpel, a pair of stout scissors with both points rounded off, two canulae and the necessary ligatures for tying them in place.

As soon as the pigeon is thoroughly under the anesthetic, the bell-jar is removed, a towel is wrapped about the head and a few drops of chloroform poured over it; the feathers are rapidly plucked from the breast and abdomen to a point just anterior to the cloaca; the skin is divided the entire distance over the keel, and the pectoral muscles dissected off from their attachment to the keel and body of the sternum for a distance of half an inch on either side of the keel.

The muscles attached to the posterior margin of the sternum are next divided close to the sternum for the distance of half an inch on either side of the median line; now raise the sternum carefully and divide the attachment of the heart. Beginning at the outer angle of the divided abdominal muscles, the body of the sternum is cut through

[1]This department is edited by C. O. Whitman, University of Chicago.

with the stout, blunt-pointed scissors, in a direction forward and inward, until a point is reached directly over the origin of the vascular trunks; repeat on the opposite side. Now grasping the keel firmly with the left hand, make traction directly upward, at the same time steadying the bird with the right hand; by this procedure the sternum is broken equally across, and the heart exposed without causing any damage to it or to the vascular trunks. Next, tear the pericardium open as quickly as possible, seize the heart, still strongly beating, between the thumb and index finger of the left hand, invert the bird over a sink and cut off with the blunt-pointed scissors the apex of the heart. In this way the blood-vessels are thoroughly emptied and the bird killed without any unnecessary suffering.

Although the description of the procedure may make it seem long, I have repeatedly done it in less than three minutes.

A canula is now inserted through the left ventricle into the aorta, and a ligature placed around it close to the point where the aorta leaves the heart. In passing the ligature around the canula, care should be exercised not to injure the vena cava or the right auricle. A second canula is passed through the right ventricle into the right auricle and secured by tying a stout ligature about the whole heart.

I have found that the best injecting mass is Gage's modification of Pausch's, colored with vermilion or ultramarine blue; this does not pass through the capillaries, sets quickly, leaving the vessels well-distended with a firm mass.

I employ a constant pressure apparatus in injecting, using a pressure of 100 mm. for the artery, but only 60 mm. for the vein; more than this will usually cause a rupture.

W. S. Miller.

Univ. of Wisconsin.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

National Academy of Sciences.—The following papers were read at the meeting commencing April 18, 1893: On the Systematic Relations of the Ophidia, E. D. Cope; Biographical Memoir of General Montgomery C. Meigs, H. L. Abbott; On the Nature of Certain Solutions, and on a New Means of Investigating Them, M. C. Lea; The Relations of Allied Branches of Biological Research to the Study of the Development of the Individual, and the Evolution of Groups, A. Hyatt; The Endosiphonoidea (Endoceras, etc.), considered as a New Order of Cephalopods, A. Hyatt; A New Type of Fossil Cephalopods, A. Hyatt; Results of Recent Researches upon Fossil Cephalopods of the Carboniferous, A. Hyatt; Biographical Memoir of Julius Erasmus Hilgard, E. W. Hilgard; Monograph of the Bombycine Moths of America, North of Mexico: Part I.—Notodontidæ, A. S. Packard; Intermediary Orbits, G. W. Hill; The Relations Between the Statistics of Immigration and the Census Returns of the Foreign-born Population of the United States, Richmond Mayo-Smith; Statistical Data for the Study of the Assimilation of Races and Nationalities of the United States, Richmond Mayo-Smith; Telegraphic Gravity Determinations, T. C. Mendenhall; Comparison of Latitude Determinations at Waikiki, T. C. Mendenhall; A One-volt Standard Cell; H. S. Carhart (introduced by T. C. Mendenhall); Fundamental Standards of Length and Mass, T. C. Mendenhall; Peptonization in Gastric Digestion, R. H. Chittenden; Helen Kellar, Alexander Graham Bell; On a Potentiality of Internal Work in the Wind, S. P. Langley; On a Bolograph of the Infra-red Solar Spectrum, S. P. Langley.

No election of members took place. The following were elected foreign correspondents: Tissandier, astronomer, Paris; Rammelsberg, chemist, Berlin; Ludwig, physiologist, Leipzig.

Boston Society of Natural History.—April 19.—The following papers were read: Mr. J. B. Woodworth: Traces of a Fauna in the Cambridge Slates; Mr. Charles P. Bowditch: Ruins of Central America. The annual meeting was held May 3d. The following paper was read: Dr. R. T. Jackson—Notes on the Development of Palms.

SAMUEL HENSHAW, *Secretary.*

New York Academy of Sciences.—April 10, 1893.—*Biological Section.*—H. F. Osborn, on "The Evolution of Teeth in Mammalia in its Bearing Upon the Problem of Phylogeny," reviewed the recent researches and theories of Kükenthal, Röse and Taeker upon the formation and succession of the dental series in mammalia, and pointed out that, especially in marsupials, cetaceans and edentates (with other placentalia) the existence of two series of teeth was now abundantly proven, as well as the fact that *Homodynamous* forms were derived from early *Heterodont.* He then showed that recent discoveries demonstrated that in marsupials, teeth of the second series might be interposed in the first series—to explain the typical dentition of such forms as Didelphys. This transposition enables a comparison of dentition of marsupials with that of Jurassic mammalia ($\doteq$ i, $\frac{4}{4}$, c, $\frac{1}{1}$, p, $\frac{4}{4}$, m, $\frac{8}{8}$). It was further noted that the triconodont type (as Amphilestes) was probably the hypothetical point of divergence of placental mammalia. As to the form of crowns, the theory (Kükenthal-Röse) that complex mammalian types were made by concrescence of simple reptilian cusps was upon the evidence of the Jurassic mammalia shown untenable, as well as the converse theory that cetaceans have derived their homodynamous form by the splitting of the cusps of triconodont.

Bashford Dean, in "Contributions to the Anatomy of Diniththys," correlated the parts of this Devon-Lower Carboniferous Arthrodiran to those of Coccosteus. Notes were made upon the (1) disposition and character of the lateral line organs, (2) pineal foramen, (3) nasal capsules, (4) dentary plates (homologies), (5) ginglymoid articulation of lateral shoulder plates, (6) character of shagreen, (7) probable disposition of paired and unpaired fins.

N. L. Britton presented a "Note on the Genus *Lechea.*" This genus of *Cistineæ* is entirely American, and from the investigations of Mr. Wm. H. Leggett and Dr. Britton appears to consist of about fourteen species.

Natural Science Association of Staten Island.—March 18.—Mr. Wm. T. Davis exhibited specimens of the Leopard Moth and read the following communication:

On the 23d of June, 1888, I found on the sidewalk, under a partly decayed white maple on Fort Hill, a large white and black moth that was rendered helpless by having one of its fore wings broken in two. It was not until last year, when Col. Nicholas Pike's article and accompanying figures on the ravages of the Leopard Moth—*Zeuzera æsculi* (Linn.)—in Brooklyn, appeared in "Insect Life," that the moth

found by me was proved to be the same species from Staten Island. Col. Pike found in 1889 that it had bored nearly all of the trees, mostly maples, from Carlton Avenue to the entrance of the park, and that in 1891 it had extended its ravages throughout the city. He also mentioned it as having appeared in Astoria, New Rochelle, Jamaica, New Lots and Flatbush.

In August, 1887, Mr. J. B. Engelman took three specimens of the Leopard Moth in Newark, N. J., and in 1888 many more were found. Previous to this the very rare occurrence of the moths in this country had been credited to the importation of wood containing the larvæ. In 1889, Mr. Beutenmuller mentions it as having been found not uncommonly in Central Park. From these facts it will be seen that this destructive insect from the Old World has become quite generally distributed in this vicinity.

Mr. Davis also read the following note:

With Messrs Kerr and Leng, on the 26th of last February, I observed about twenty-five Snow Buntings—*Plectrophenax nivalis* (Linn.)—in a field on Todt Hill, near the highest point of the island. They were feeding in the few places where there was no snow, and flew occasionally in a remarkably compact flock, from one to another of these isolated spots. This bird has not been reported on the island for a number of years, and its present occurrence is undoubtedly due to the severity of the winter.

Mr. J. H. Bowles, in "Science," for January 13th, 1893, comments upon the abundance of the Pine Grosbeak—*Pinicola enucleator* (Linn.) —and the scarcity of the Snow Bunting about Ponkapoag, in eastern Massachusetts, and gives as a cause the unusually cold weather. The Grosbeaks and the Buntings have each ranged further south than for several years past. Though the weather has been severe, robins have been seen sparingly on the island during every month of the winter.

Mr. Arthur Hollick remarked that the last time he remembered seeing the Snow Buntings in abundance in this vicinity was during the winter of 1872–73, when they appeared in great flocks, accompanied by the Horned Lark—*Otocoris alpestris* (Linn.). That winter they were particularly numerous on Fort Hill, New Brighton, during many days in December and January, and large numbers were killed by gunners.

Mr. Walter C. Kerr exhibited, under the microscope, leaves of *Quercus nigra* L., *Q. ilicifolia* Wang., and *Q. brittonii* Davis, and read the following paper in connection with them:

In describing the new hybrid, *Quercus brittonii*, in our Proceedings for September 10th, 1892, Mr. Davis refers to the pubescence of the under surface of its leaves being intermediate between that of *Q. ilicifolia* and *Q. nigra.* This observation was made from casual inspection, without reference to the exact nature of the pubescence. Under the microscope it will be seen, as in specimens submitted, that the *Q. ilicifolia* has so dense a pubescence that the epidermis is completely hidden, while in *Q. nigra* the tufts are quite separated, even isolated. In *Q. brittoni*, the hybrid between these species, the intermediate character of the pubescence is most striking, the under surface of the leaves being starred at regular intervals by the tufts, which are usually sufficiently close to allow their spreading hairs to touch one another. These tufts seem to be composed of six to twelve hairs spreading from a common base and occupying a space about .15 to .2 mm. in diameter.

An average specimen contains about sixteen tufts per square mm., while in any other, representing the strongest pubescence which the hybrid seems to attain, about twice this number were present and somewhat smaller in size, indicating considerable variation in these appendages.

The wide difference in pubescence of *ilicifolia* and *nigra*, however, is such that a variation of even one hundred per cent. between different specimens of *Q. britonii* is not sufficient to materially affect the distinctiveness of this characteristic.

Mr. Arthur Hollick called attention to the fact that an earthquake shock had been experienced on the island shortly after midnight on March 8th, which had been sufficiently severe to awaken many people, especially those who resided on the hills in New Brighton, but that it did not seem to have been felt generally throughout the rest of the island.

Mr. Jos. G. Thompson stated than he found, on South Beach, a dead specimen of the Tom-Cod (*Gadus tomcodus*), about eight inches long, which had made a meal of eight mud-killies (*Umbri limi*). Those that were in the foremost part of the stomach were quite perfect, while the others that were further down had begun to be dissolved by the digestive fluids.

April 8.—Mr. Arthur Hollick exhibited specimens of Indian rubbing stones and read the following paper concerning them :

Since our last meeting, while on a tramp across the island from Pleasant Plains to Rossville, I was struck by the fact that the shell heaps, which have been noticed in that region at different times, form practically a continuous chain or trail from shore to shore. They follow

the course of Sandy Brook up to Woodrow road, and from thence may be found in nearly every field or piece of cleared ground until we reach the village of Rossville. Indian implements of various kinds, with fragments of pottery have been picked up at many points and are likely to be met with in any part of the region. The distance of some of these accumulations from the shore, their elevation above the water, and the fact that in many places they are spread thinly and evenly on the surface has led me to think that the more distant ones from the salt water may have been carried there in recent times by the farmers for purposes of fertilization, as is frequently done. Whether this be so or not, implements may be found wherever the shells occur, proving their origin indisputably.

Amongst a number of relics found at the time mentioned was an unusually fine specimen of a rubbing or polishing stone—an implement of which few have turned up on Staten Island, and in regard to which I believe, the attention of the Association has never been called. Amongst the hundreds of implements which our members have collected during the past ten or twelve years from all parts of the island, I find but seven which can be classed in this category—all, with the exception of this one, from Tottenville.

Mr. William T. Davis presented nine plants, new or rare to the flora of the Island, with the following memoranda:

Rubus odoratus L. Side of Todt Hill road near the highest point. Spreading from introduced plants. *Aethusa cynapium* L. Abundant in a field corner Crescent and Jersey streets, New Brighton. Previously reported only from Clove Lake swamp. *Oxycoccus macrocarpus* Pers. Near Sprague avenue, Tottenville, and accompanied by the "Cotton grass" (*Eriophorum*) as in the swamp near Richmond village. *Vaccinium pennsylvanicum* Lam. Watchogue and Arlington. *Stachys palustris* L. var. *cordata*. Abundant in field near Eltingville station. *Pinus mitis* Michx. Abundant at Linoleumville. *Habenaria blepharoglottis* Hook. Sparingly at Watchogue along Merrill's road. *Calopogon pulchellus* R. Br. Merrill's road near trap ridge. Collected by C. W. Leng. *Smilacina stellata* Desf. Borders of salt meadow at Great Kills.

Mr. Walter C. Kerr exhibited a large fragment from the broken trunk of a horse chestnut tree, showing profuse budding, and read the following paper:

Some features surrounding the adventitious budding of a horse chestnut, *Æsculus hippocastanum* L., on Tompkinsville Hill may be worthy of passing notice. On the bleak eastern brow of the hill there stands,

among the few scattered trees remaining, a horse chestnut about 18 inches in diameter, branching about three feet from the ground into two trunks, each about ten inches in diameter. The trunk leaning to the eastward is thriving and about the normal height for its diameter. The one leading to the westward has broken off, with an irregular splintery fracture, about five feet from the ground, perhaps on account of its lesser resistance to our easterly gales, and the stump has rotted badly. The bark, however, retains its vigor, and from the cambium layer, where exposed along the irregular edges of the ruptured section, adventitious buds have sprouted profusely. They are also found where the bark has split, and in the crotch where the tree has forked, where the bark of the two trunks unite. Some of the thickest colonies of buds were at the apex of the splintered stump, and I therefore sawed off about fifteen inches with its buds and three young shoots which have seemed fortunate enough to grow to the length of some eight inches. It will be noted that the bark is in a good state of preservation, the inner layers alive, while the wood is not only dead, but far gone in decay. The thickest cluster of buds is 8 inches long by 1½ inches wide, and within this space I have counted 200, about 30 of which are alive, the others being mostly the remains of a previous crop. There is no evidence of accidental destruction of the buds, though a few small shoots may have been cut off. Cows would scarcely browse on them, and one cluster occupied an inaccessible position in the fork.

One is not surprised at the dense growth of shoots which rise from adventitious buds on a decapitated willow or the spraying branches of elm which are of similar origin, but I have never before noticed so profuse a crop of buds whose mission seems to be entirely futile. They seem to represent an especially vigorous effort of the broken organism to survive, and under the circumstances this effort might be very persistent because of the opportunity afforded the unfortunate trunk, deprived of means of assimilation, to draw on the sister trunk, fully developed, for the requisite nourishment. It therefore might seem to have more opportunity to thus maintain its life than had it been a single trunk snapped off and dependent only on the residual nourishment within its roots. This supposition is, in some degree, supported by the fact that this particular tree stands on a hill some 300 feet high, rooted in the thin, dry soil covering a barren serpentine ledge, and hence would scarcely be expected to show a vigor which compares favorably with the sprouting of the adventitious shoots of the brookside willow. The specimen from the stump shows only three small surviving shoots, and may it not be fairly surmised that if the budding effort

of the cambium layer of this old stump could have been concentrated into a few buds and their resultant shoots, the struggle for existence would have been more successful. It would seem, even in the absence of positive evidence, as though the prolificness with which the buds were formed seriously retarded the survival of any, and thus the ability of the cambium layer of this stump to restore the interrupted growth was handicapped by the opportunity afforded for abnormal budding effort through the supply of nourishment obtainable from the uninjured half.

Mr. George Dupuy exhibited a series of about 400 drawings representing Staten Island pond life—diatoms, desmids, algae and infusoria —all drawn to scale on cards, handsomely colored and arranged.

The Biological Society of Washington.—April 8.—The following communications were made: Professor J. W. Chickering—The Botanical Landscape; Frederick V. Coville—Characteristics and Adaptations of a Desert Flora; Dr. C. W. Stiles—Notes on Parasites; The Cause of "Measly Duck," with microscopic demonstration; Dr. R. R. Gurley—Natural Selection as Exemplified by the Cackling of Hens.

April 22.—The following communications were made: Mr. O. F. Cook—Notes on the Natural History of Liberia; Dr. J. N. Rose—Two New Trees of Economic Importance from Mexico; Dr. V. A. Moore—Observations on the Distribution and Specific Characters of the Streptococci Group of Bacteria; Dr. Erwin F. Smith—Peach Yellows and Plant Nutrition. FREDERICK V. COVILLE, *Secretary.*

Geological Society of Washington.—A Geological Society has recently been organized in Washington, D. C., for the presentation and discussion of topics of interest to geologists. The constitution and standing rules were subscribed to by 109 founders at the first public meeting, March 8th, 1893. Its members are of two classes, active and corresponding. The annual dues of the first are $2, and of the second, $1. Meetings will be held on the second and generally also on the fourth Wednesday of each month from October to May, inclusive.

The journals and bulletins of the various societies appear to furnish sufficient opportunity for the publication of papers read before the Society, so that for the present the Society will not undertake to publish the papers presented. It will probably issue one bulletin each year containing the address of the retiring President, and such other matter as the Council directs. J. S. DILLER, *Secretary.*

SCIENTIFIC NEWS.

Correction.—Dr. D. S. Jordan informs me that the name *albeolus* is not available for a new species of *Notropis* since it has been used in that connection. The species called *Notropis albeolus* in the AMERICAN NATURALIST, January, 1893, p. 152, may stand as *Notropis jordanii.* C. H. & R. S. EIGENMANN.

Alphonse Louis Pierre Pyramus DeCandolle, born in Paris, October 27, 1806, died in Geneva, April 4, 1893. The son of an eminent botanist (Augustin Pyramus DeCandolle, 1778–1841), with whom he labored many years, and himself the father of one who ranks high among living botanists (Casimir Pyramus DeCandolle, 1836——), the subject of this sketch lived all his days a botanist. His first paper, *Monographie des Campanulées,* appeared in 1830, and from that date until within a short time, his brain and pen have been busy. In 1839 he began his contributions to the "Prodromus" which his father had inaugurated fifteen years earlier, continuing until the final abandonment of the work in 1873. A few years later (1878) he and his son Casimir brought out the first volume of *Monographiae Phanerogamarum,* which was intended as in part, a continuation and revision of the *Prodromus.* Of this great work, seven stately volumes have appeared.

Aside from this systematic and descriptive work, DeCandolle will be remembered for his treatise on geographical botany, *Geographie Botanique Raisonnée* (2 vols., 1855), and his well known *Lois de la Nomenclature Botanique* (1867), of which an English translation appeared the year following. The latter, in these days of discussion, is not likely to be forgotten or overlooked. *La Phytographie,* which appeared from his pen in 1880, is not as well known as its merits deserve. The much more popular *Origin du Plants Cultivês* (1885), of which an English translation appeared in the International Scientific Series is one of the most widely read of botanical works.

Lectures at the Paris Museum.—The following course of lectures will be given at the Museum of Natural History during 1893:

April 25, Preliminary Lesson, M. Milne-Edwards; April 27, Anthropology, M. Hamy; April 29, Ethnography, M. Verneau; May 2, Mammalia, M. Oustalet; May 4, Birds, M. Oustalet; May 6,

Reptiles and Fishes, M. Vaillant; May 9, Molluscs, M. Perrier; May 13, Worms and Zoophytes, M. Bernard; May 16, Insects and Crustaceans, M. Ch. Brongniart; May 18, Comparative Anatomy, M. Pouchet; May 20, Botany (Phanerogams), M. E. Bureau; May 23, Botany (Wood, Cryptogams), M. Van Tieghem; May 25, Living Plants, M. Cornu; May 27, Paleontology, M. Albert Gaudry; May 30, Geology, M. Stanislas Meunier; June 1, Meteorology, M. Daniel Berthelot; June 3, Mineralogy, M. Lacroix; June 6, Hygiene for Travelers, M. Gréhaut. (Revue Scientifique, April, 1893.)

The Nottingham Meeting of the British Association for the Advancement of Science will be held under the presidency of Professor Burdon-Sanderson, the well-known physiologist. The presidents of the Natural History Sections are to be: Geology, J. J. H. Teall; Biology the Rev. Canon Tristram; Geography, Mr. Henry Seebohm; Anthropology, Dr. Robert Monro.

Dr. Dall has done a good work in ascertaining the dates of the late Timothy A. Conrad's books upon the Tertiary fossils of the United States. The quarrel which was their cause or their effect has fortunately passed into ancient history, and these unfortunate volumes show the ground of its permanent settlement.

The cousins Sarasin, so well known for their expedition to Ceylon to study the development of the Cæcilians, are about to start for a several years' stay in the Celebes.

The Rev. H. N. Hutchinson, 30 Vincent Square, Westminster, London, S. W., England, has, for sale, plaster casts of a model of the horned saurian Agathaumas, 12 inches long, for ten shillings.

Professor Karl August Lossen, Chief Geologist of the Prussian Survey and Professor of Geology in the University of Berlin, died February 24, 1893. Most of his geological work was done in the Hartz Mountains. He was born January 5, 1841.

Professor Karl Prantl, of the University of Breslau, died February 24, 1893, in his forty-fourth year. He is best known for his text-book translated by Professor Vines, and for his share in the "Pflanzenfamilien" of which he and Professor Engler of Berlin were joint editors. This work is, however, so near completion that it will probably be but slightly delayed. He also edited the Moss magazine, "Hedwigia."

Edward Parfitt, a student of the Geology of Devonshire, England, died June 15, 1893, in his 73d year.

The Marine Biological Laboratory at Woods Hall, Mass.

INCORPORATED IN 1888. SIXTH SEASON, 1893.

OFFICERS OF INSTRUCTION.

C. O. Whitman, Director, Head Professor of Zoology the University of Chicago; Editor of the Journal of Morphology.

ZOOLOGY.

A. *Investigation.*

Howard Ayers, Director of the Allis Lake Laboratory, Milwaukee; J. Playfair McMurrich, Professor of Biology, University of Cincinnati; E. G. Conklin, Professor of Biology, Ohio Wesleyan University; F. R. Lillie, Fellow in Zoology, Chicago University.

B. *Instruction.*

H. C. Bumpus, Professor of Comparative Anatomy, Brown University; W. M. Rankin, Instructor in Zoology, Princeton College; Pierre A. Fish, Instructor in Physiology and Anatomy, Cornell University; A. D. Mead, Fellow in Zoology, University of Chicago.

BOTANY.

W. A. Setchell, Instructor in Botany, Yale University; W. J. V. Osterhout, Brown University.

PHYSIOLOGY.

Jacques Loeb, Assistant Professor of Physiology, University of Chicago.

Ryoiche Takano, Artist; F. W. Walmsley, Collector; G. M. Gray, Laboratory Assistant.

In addition to the regular courses of instruction in Zoology, Botany, Embryology and Microscopical Technique, consisting of lectures and laboratory work under the constant supervision of the instructors, there will be a number of lectures on special subjects by members of the staff. A course of lectures in Embryology will be given by Professor Whitman; on the Morphology of Vertebrate Head, by Dr. Ayers, and two or more courses in Invertebrate Zoology, by Drs. Bumpus, McMurrich, Rankin and Morgan.

There will also be ten or more evening lectures on biological subjects of general interest. Among those who may contribute these lectures may be mentioned, in addition to the instructors above-named, the following:

Drs. E. A. Andrews, Johns Hopkins University; Howard Ayers, of the Allis Lake Laboratory; Professors W. G. Farlow, Harvard University; William Libbey, Jr., Princeton College; J. M. Macfarlane, University of Pennsylvania; C. S. Minot, Harvard Medical School; E. S. Morse, Salem; H. F. Osborn, Columbia College; John A. Ryder, University of Pennsylvania; W. T. Sedgwick, Mass. Institute of Technology; E. B. Wilson, Columbia College.

The Laboratory is located on the coast at Woods Holl, Massachusetts, near the Laboratories of the United States Fish Commission. The building consists of two stories, and has 33 private laboratories for investigators and 5 general laboratories—two for beginners in investigation in Zoology, one for teachers and students receiving instruction in Zoology, one for Botany, and one for Physiology. The Laboratory has aquaria supplied with running sea water, boats, a steam launch, collecting apparatus and dredges; it is also supplied with reagents, glassware and a limited number of microtomes and microscopes. *No alcohol can be supplied beyond what is required for work in the laboratory.*

By the munificence of friends, the library will be provided not only with the ordinary text-books and works of reference, but also with the more important journals of zoology and botany, some of them in complete series.

THE LABORATORIES FOR INVESTIGATORS

will be open from June 1 to August 30. They will be equipped with aquaria, glassware, reagents, etc., *but microscopes will not be provided.* In this department there are 33 private laboratories for the exclusive use of investigators.

Those who are prepared to begin original work under the guidance of instructors, will occupy tables in the general Laboratories for Investigators, paying for the privilege a fee of fifty dollars. The number of such tables is limited to 20.

An Elementary Course in vertebrate embryology will be introduced this season, designed to meet the needs of those who have completed the general courses in the Students' Laboratory. The study will be confined mainly to the fish egg, as the best type for elucidating vertebrate development. Each member of the class will be supplied with material, and be expected to work out each step in the development from the moment of fecundation. The aim will be not only to master the details of development, but also to acquire a thorough knowledge of the methods of work. Methods of preparing surface views, imbed-

ding in paraffin and celloidin, various methods of staining and mounting, drawing, reconstructing, modeling, etc. The course will thus combine just what is needed as a preparation for investigation.

This course will open Wednesday, July 5, and continue six weeks, and it will be conducted by Mr. Lillie and Professor Whitman. The fee for this course will be fifty dollars, and the class be limited to ten.

Applicants should state what they have done in preparation for such a course, and whether they can bring a complete outfit, viz.: a compound microscope, a dissecting microscope (the Paul Mayer pattern made by Zeiss is the best), camera-lucida, microtome, etc. In case these instruments are furnished by the Laboratory, an additional fee of ten dollars will be charged therefor. No application for less than the whole course will be granted.

THE ZOOLOGICAL LABORATORY FOR TEACHERS AND STUDENTS

will be opened on Wednesday July 5, for regular courses of six weeks in Zoology and Microscopical Technique. The number admitted to this department will be limited to fifty, and preference will be given to teachers and others already qualified. By permission of the Director and by the payment of additional fees, students may begin their individual work as early as June 15, but the regular instruction will not begin before July 5.

Though more advanced students who may wish to limit their work to special groups will have an opportunity to do so, the regular course in Zoology, in charge of Professor Bumpus, will embrace a study of the more typical marine forms and elementary methods of Microscopical Technique. The Laboratory work, outlined below, will be accompanied by lectures.

July 5–8, Study of the Lobster (general anatomy, methods of injecting, preparation of histological material); July 10–15, Coelenterates (*Campanularia, Tubularia, Metridium, Mnemeopsis*); July 17–22, Vermes (*Nereis, Balanoglossus* and *Phascolosoma, Polyzoa, Bdelloura*); July 24–29, Echinoderms (*Asterias, Arbacia, Echinarachinus, Thyone*); Molluscs (*Venus, Sycotypus, Loligo*); July 31–Aug. 5, Crustaceans (*Branchipus, Pandarus, Lepas, Idotea, Talorchestia, Cancer, Limulus*); August 7–15, Vertebrates (*Amphioxus, Raja*, Teleost).

The tuition fee is thirty-five dollars, payable in advance. Applicants should state whether they can supply themselves with simple and compound microscopes, or whether they wish to hire. Microscope slides, dissecting and drawing instruments, bottles, and other supplies, to be finally taken away, are on sale at the Laboratory. Further

information in regard to this department may be had by addressing Professor Hermon C. Bumpus, Woods Holl, Mass., to whom applications for admission should also be made.

THE BOTANICAL LABORATORY FOR TEACHERS AND STUDENTS

will be opened on Wednesday, July 5. The laboratory work in Botany will be restricted to the study of the structures and development of types of the various orders of the Cryptogamous Plants. Especial attention will be given to the study of the various species of Marine Algæ which occur so abundantly in the waters about Woods Holl, and students desiring to give their entire attention to these plants will be encouraged to do so. The Fungi and Higher Cryptogams will receive less attention than the Algae, and will be studied in fewer types. Lectures will accompany the laboratory work. The course may be outlined somewhat as follows:

First week, *Cyanophyceæ*—Lyngbya, Calothrix, Rivularia, Stigonema, Tolypothrix, Anabæna. Second week, *Chlorophyceæ*—Spirogyra, Ulva, Enteromorpha, Chætomorpha, Bryopsis, Vaucheria, Œdogonium; *Phaeophyceae*, Ectocarpus, Mesogloia, Leathesia, Laminaria, Fucus, Sargassum. Third week, *Rhodophyceæ*—Batrachospermum, Nemalion, Callithamnion, Chondriopsis, Rhabdonia. Fourth week, *Phycomycetes*—Mucor, Sporodinia, Peronospora, Cystopus, Achlya; *Uredinei*, Æcidium, Uredo, Puccinia, Uromyces. Fifth week, *Basidiomycetes*—Agaricus, Lycoperdon; *Ascomycetes*—Microsphæra, Sordaria, Peziza, Physcia. Sixth week, *Muscineæ*—Riccia, Madotheca, Marchantia, Mnium, Tetraphis, Hypnum; *Filicineæ*—Dicksonia, Adiantum, Equisetum, Lycopodium, Marsilia, Selaginella.

The tuition for students in the regular course of laboratory work and lectures is thirty-five dollars, payable in advance; for students engaged in investigation the tuition is fifty dollars.

Students are expected to supply their own instruments, or to pay an extra fee for those borrowed from the Laboratory. Applications should be addressed to William A. Setchell, 2 Hillhouse Ave., New Haven, Conn.

The Physiological Laboratory will be open from June 1 to September, for investigators.

Rooms accommodating two persons may be obtained near the Laboratory, at prices varying from $2.00 to $4.00 a week, and board from from $4.50 to $6.00. By special arrangement, board will be supplied to members at The Homestead at $5.00 a week.

A DEPARTMENT OF LABORATORY SUPPLY

has been established in order to facilitate the work of teachers and others at a distance, who desire to obtain materials for study or for class instruction. Certain sponges, hydroids, starfishes, sea-urchins, marine worms, crustaceans, molluscs, and vertebrates are generally kept in stock, though larger orders should be filled some time before the material is needed. Circulars giving information, prices, etc., may be obtained by addressing the Collector, Mr. F. W. Walmsley, Woods Holl, Mass.